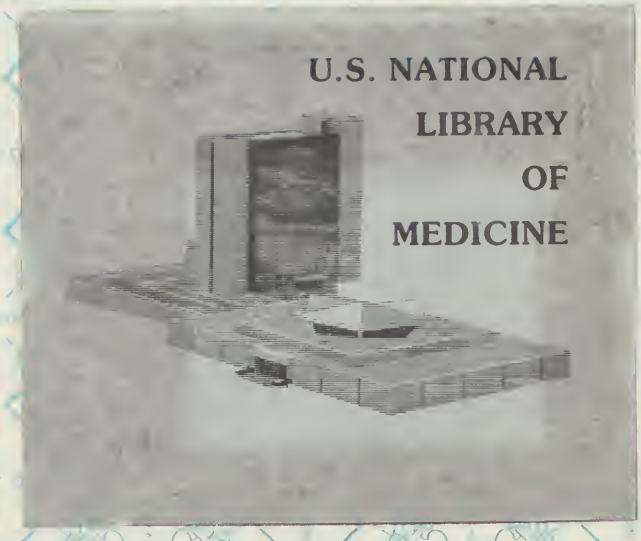


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AVIATION MEDICINE TECHNICIANS' MANUAL

SCHOOL OF AVIATION MEDICINE
U. S. NAVAL AIR STATION
PENSACOLA, FLORIDA

FOREWORD

This manual has been prepared with the hope and belief that it will be of benifit to Aviation Medicine Technicians, during their course of instruction and in their daily work after graduation.

The data herein has been compiled with the aid of official text books, Service publications, The Manual of the Medical Department, Bureau Circular letters and Bulletins. It is not intended that this manual should replace or supplement any text on various subjects of aviation medicine. The subjects dealt with are those that are considered of importance in training an Aviation Medicine Technician for the type of work he is to perform. It was with this idea in mind that this manual was compiled and published.

The Medical Officer herewith expresses appreciation to Lieutenant Commander T. D. BOAZ, (MC), USN., for his work in the editing and preparation of this manual, and to the following personnel of the School of Aviation Medicine, U.S. Naval Air Station, Pensacola, Florida, who assisted in its preparation: Lieutenant D. C. GATES, (MC), USNR., Lieutenant (jg) E.R.V. ANDERSON, (MC), USNR., and Chief Pharmacist's Mate H. G. LEAK, Jr., USN.

Frederick Ceres

FREDERICK CERES,
Captain, Medical Corps, USN.

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SECTION I

EYE

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ANATOMY AND PHYSIOLOGY OF THE EYE

The eyes are the organs of sight and each is situated in the bony orbital cavities of the face. This cavity (ORBIT) has the shape of a quadrilateral pyramid, with the apex cut off (the OPTIC FORAMEN) and pointing backwards towards center of skull. The base of the pyramid is represented by the opening in upper part of the face on each side of nose.

The eyeball is loosely imbedded in a pad of fat and is supported by a membrane of fibrous tissue (TENON'S CAPSULE) which extends from behind the eye at the optic foramen forward to the anterior portion of the eyeball, a little way back of the LIMBUS (cornea-scleral junction). The extra-ocular muscles of the eye are incorporated within the capsule and form part of it.

The eyes are covered and protected anteriorly by the LIDS, which are a movable fold consisting of, from before backwards:

(a) Skin
(b) Loose areolar connective tissue
(c) Muscle tissue
(d) Tarsus (a fibrous plate--feels almost like cartilage) and fascia.
(e) Conjunctiva
(f) Lids also contain eye lashes, glands, blood vessels, lymphatics and nerves.

MUSCLES OF LIDS:

(1) ORBICULARIS MUSCLE--forms a flat circle around the opening between the upper and lower lids and lies between the tarsus and the skin. Its function is to close the lids.

(2) LEVATOR PALPEBRUM SUPERIOR--arises at upper border of bony optic foramen--passes forward above eyeball and is inserted in upper border of tarsus of upper lid and into skin of upper lid. Its function is to raise the upper lid.

THE CONJUNCTIVE

The conjunctiva is a thin layer of mucous membrane which lines the inner side of the eyelids and is firmly adherent to the tarsus and is reflected on to the eyeball where it is thicker and very loosely attached. The formix (upper and lower) is where the conjunctiva is reflected from the under side of lid to the eyeball. The space between the lid and eyeball is known as the CONJUNCTIVAL SAC.

LACRYMAL APPARATUS

The lacrymal (tear) gland is situated in the upper and outer part of the orbit just back of the prominent bony rim of the eye.

It secretes a watery (tears) lubricant into the conjunctival sac. Ordinarily, just enough tears are secreted to keep the eyeball moist, and there is a balance between secretion and evaporation.

When its secretion is increased (emotional upset, conjunctival irritation, smoke, etc.) the excess is taken up by the small openings (PUNCTA) near inner angle of eye on upper and lower lid margins, passes through small canals and finally down into nose. Hence, a crying child usually needs to blow its nose.

OPTIC NERVE

The optic nerve leaves the eye through an opening in the sclera. This opening is a little to the inner side of the back part of the eyeball. The nerve then passes backward through the optic foramen to the brain. It conveys impulses picked up by the eye (retina) back to the brain.

EYEBALL

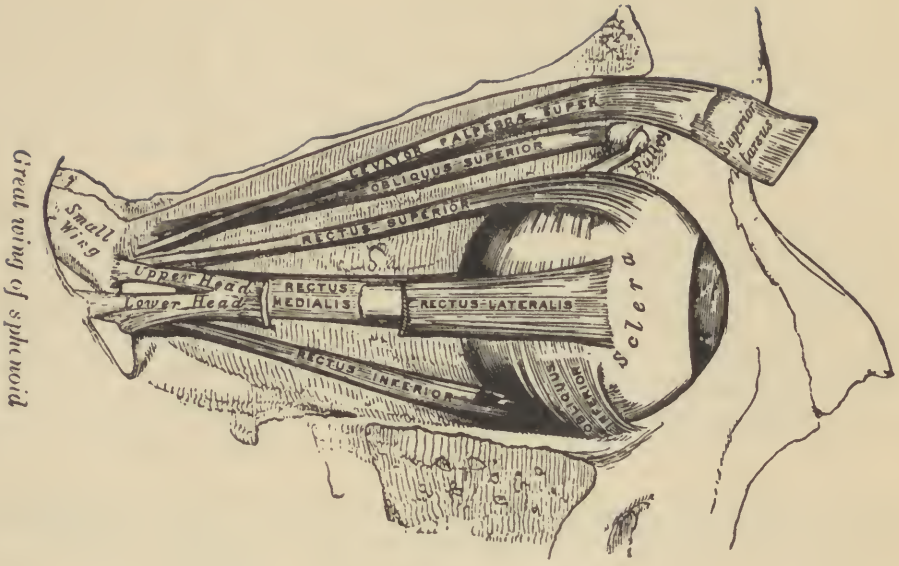
The general shape of the eyeball is spherical. It is composed of segments of two spheres of different sizes, the anterior being a segment of the small sphere forming about 1/6 of the eyeball (the cornea) and the posterior being the segment of a much larger sphere, forming the other 5/6 of the eyeball (covered by sclera).

The wall of the eyeball is made up of three layers:

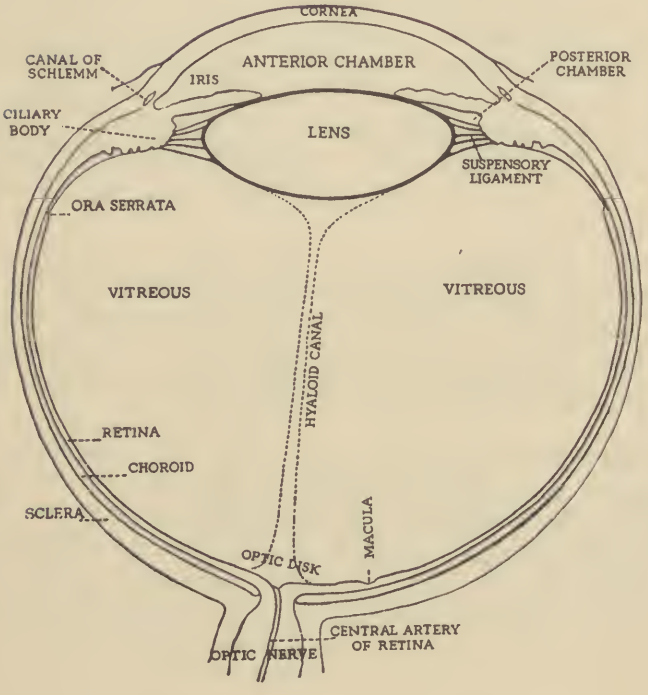
1. Outer layer
   - Cornea
   - Sclera
2. Middle layer (uveal tract)
   - Iris
   - Ciliary body
   - Choroid
3. Retina

THE CORNEA is the clear, transparent, anterior portion of the external coat of the eyeball. It is continuous posteriorly with the sclera. Its function is to give shape and to act as a refracting surface. The refracting power of the cornea is greater than all other structures of the eye combined (including the lens) and amounts to about 41 diopters.

THE SCLERA is the white outer covering of the posterior 5/6 of the eyeball. It is quite strong, whitish, opaque, elastic (to a small degree), and serves to maintain the form of the globe. It is pierced posteriorly by the optic nerve and is continued anteriorly with the cornea.



Muscles of the right orbit.



Horizontal Section of the Eyeball. Magnified about 3½ ×.

THE IRIS is a colored membrane, circular in form, hanging behind the cornea and immediately in front of the lens. It is perforated in the center by a round aperture of variable size called the pupil, which serves to regulate the amount of light admitted to the interior of the eye. It acts similarly to the circular shutter of a box camera, or the light regulator under the stage of a microscope. The iris consists of connective tissue, radiating (to dilate) and circular (to contract) muscles, and many delicate nerve endings. These nerve endings are light sensitive and act to change rapidly the size of the pupil with changes of intensity of light.

THE CILIARY BODY is the part of the uveal tract that extends backwards about 6mm. from the iris and is continuous with the choroid posteriorly. It has a rich blood supply and is composed of circular and radial muscle fibers which, through the ligaments attached to the rim of the lens, controls the thickness (refractive power) of the lens. The activity of these muscles and the elasticity of the lens is what we test when determining an individual's accommodation.

THE CHOROID is the dark brown membrane which lies between the sclera and the retina. It is composed of a layer of pigment and many blood vessels. The chief function of the choroid is to serve as a nutrient organ for the retina and inner structures of the eye.

THE RETINA is a thin delicate membrane which consists of an expansion of the optic nerve. It lies between the choroid externally and the vitreous internally. It is attached to the choroid in only two places, around the optic disc at the back of the eye and at the outer anterior edge of the retina a few mm. back of the ciliary body. This peripheral retinal margin is called the ORA SERRATA. The retina is held in place against the choroid by the vitreous body.

On the inner side of the posterior portion of the retina is a pale, whitish-pink, round area, the OPTIC DISC, corresponding to the anterior end of the optic nerve. This optic disc or Nerve Head is slightly raised above the retina and is pierced near its center by the central retinal artery and its vein.

Lateral to the disc and corresponding to the posterior pole of the eye is a small yellow spot called the FOVEA CENTRALIS. This spot is surrounded by a small darker area called the MACULA. This area is devoid of visible blood vessels and is the most sensitive portion of the retina. This is the area we use when the eye focuses on one particular spot. It is the portion we use when we read a book.

The RETINA contains the sensitive nerve endings of sight which pick up the sensations of light and are conveyed to the brain via the optic nerve. It corresponds to the sensitive film of a camera.

THE VITREOUS is a transparent, colorless, jelly-like mass that fills the posterior cavity of the eye from behind the lens back to the optic disc. It has form, is under slight pressure, and helps to keep the retina in place against the choroid. It has no blood vessels and receives its nourishment from surrounding structures.

THE AQUEOUS HUMOR is the clear, watery fluid which fills the front cavity of the eyeball (the aqueous chamber). This chamber is divided into two parts. (1) The anterior chamber, which extends from the back of the cornea to the front of the iris, and (2) the posterior chamber, which extends from the iris to the front part of the lens.

THE LENS is a transparent, colorless body, biconvex in shape, suspended in the anterior portion of the eyeball, between the aqueous humor and the vitreous. It is about 5 mm. thick and 9mm. in diameter. It is shaped like a small, round button that is thick in the middle and tapers to the edge. It is called the crystalline lens; however, it is not hard like a crystal. The center portion (nucleus) of the lens substance is rather firm but the surrounding substance (cortex) is a semi-solid, jelly-like substance. The entire lens is covered by a thin, homogeneous, elastic membrane, called the capsule, which covers the lens and is known as the anterior capsule in front and as the posterior lens capsule behind.

The lens has no blood vessels. It is held in place by the suspensory ligament of the lens, which is attached to the lens rim and to the ciliary muscle.

The function of the lens is to focus rays of light so that they form a perfect image on the retina. This alteration in refractive power of the lens is known as accomodation , and is produced by a change of shape mainly affecting its anterior curvature. In the young baby, the lens has the power to accommodate as much as 14 diopters. This power gradually decreases with hardening changes in the lens substance until, at the age of 70 there are only .25 of a diopter remaining.

THE EXTERNAL MUSCLES OF THE EYE

There are six (6) muscles that control the movement of the eyeball. They all arise from the wall of the orbit and all except one (inferior oblique) arise near the apex of the orbit around the optic foramen and pass forward and are inserted into the sclera 5 to 8 mm. back of the limbus (cornea-scleral junction).

OCULAR MUSCLES

MUSCLE	ORIGIN	INNERVATION	INSERTION
1. External Rectus	Optic Foramen	Abducens Nerve	Temporal side of eyeball, anterior of equator
2. Internal Rectus	Optic Foremen	Oculomotor Nerve	Nasal side of eyeball, anterior of equator
3. Superior Rectus	Optic Foremen	Oculomotor Nerve	Superior surface of eyeball anterior of equator
4. Inferior Rectus	Optic Foramen	Oculomotor Nerve	Inferior surface of eyeball anterior of equator
5. Superior Oblique	Optic Foramen	Trochlear Nerve	Superior surface of eyeball temporal side, posterior of equator
6. Inferior Oblique	Superior Maxilary Bone	Oculomotor Nerve	Inferior surface of eyeball temporal side, posterior of equator.

THE ACTION OF THE MUSCLES

To understand the action of these muscles, the student should try to visualize the eyeball moving about a center of rotation--near the center of the eyeball. Just consider this point as remaining in the exact same position at all times and that the portion behind, in front of, above and below do the moving or rotating about this point. When the eye is rotated out the front part rotates outward and the back portion rotates inward, etc.

External rectus rotates the eyeball outward.

Internal rectus rotates the eyeball inward.

Superior rectus rotates the eyeball upward, mainly, and Secondarily, inward with slight intorsion (upper part of the eye rotates inward and lower part outward). The main function (upward rotation) can best be tested by having the eye turned slightly outward before trying to rotate it upward. This is called the field of action, which in this case is temporal.

Inferior rectus rotates the eyeball downward, mainly, and secondarily, inward with slight extorsion (upper part of the eye moves outward and lower part inward). The main function (downward rotation) can best be tested by having the eye turned slightly outward before trying to rotate it downward. The field of action is said to be temperal.

Superior oblique--the muscle passes forward from origin at optic foramen to upper inner angle of front of orbit, passes over a small bony hook (trochlea), then passes back and outward to insertion in sclera at superior temporal portion of the eye behind the center of rotation, or behind equator of the eye. From a functional standpoint the muscle may be considered to arise

from the trochlea (bony hook) at upper medial portion of front of orbit.

The main function is to depress (downward rotation) and secondarily, outward rotation with slight intorsion. The main function (depression) can best be tested by having the eye turned slightly inward before trying to rotate it downward. The field of action is nasal.

Inferior oblique arises from the inner lower portion of the orbit just below the lower tear duct opening and passes out and back to scleral insertion behind center of rotation of eyeball.

The main function is to elevate (upward rotation), and, secondarily, outward rotation and slight extorsion.

The main function (elevation) can best be tested by having the eye turned slightly inward before trying to rotate the eye upward--field of action is nasal

Diagram showing action of individual muscles of the left eye in the six cardinal directions of gaze from the primary position or position of "eyes front".

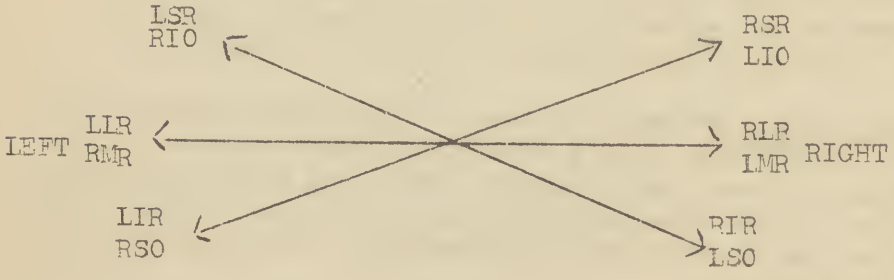


Diagram showing conjugate or yoke action of extrinsic ocular muscles of both eyes in binocular movements.

BINOCULAR MOVEMENTS--when we consider binocular movements we find that a change of position from "eyes front" to a different position within the field of binocular fixation is accomplished by the combined action of muscles of each eye. The muscles that by their contraction maintain the two visual lines parallel in combined movements of the two eyes are termed conjugate or yoke muscles. For example, in looking toward the right from the position of "eyes front" the right external rectus and left internal rectus contract. Below is a table showing the conjugate or yoke muscles brought into play in movements in the six cardinal directions from the position of "eyes front".

TO THE RIGHT--Right external rectus and left internal rectus.
TO THE LEFT--Left external rectus and right internal rectus.
UP AND TO RIGHT--Right superior rectus and left inferior oblique.
DOWN AND TO RIGHT--Right inferior rectus and left superior oblique.
UP AND TO LEFT--Left superior rectus and right inferior oblique.
DOWN AND TO LEFT--Left inferior rectus and right superior oblique.

OCULAR MUSCLE IMBALANCES

In order to properly understand the various imbalances, to test for these conditions and to properly understand their relationship to Aviation Medicine several terms and conditions should be defined and explained.

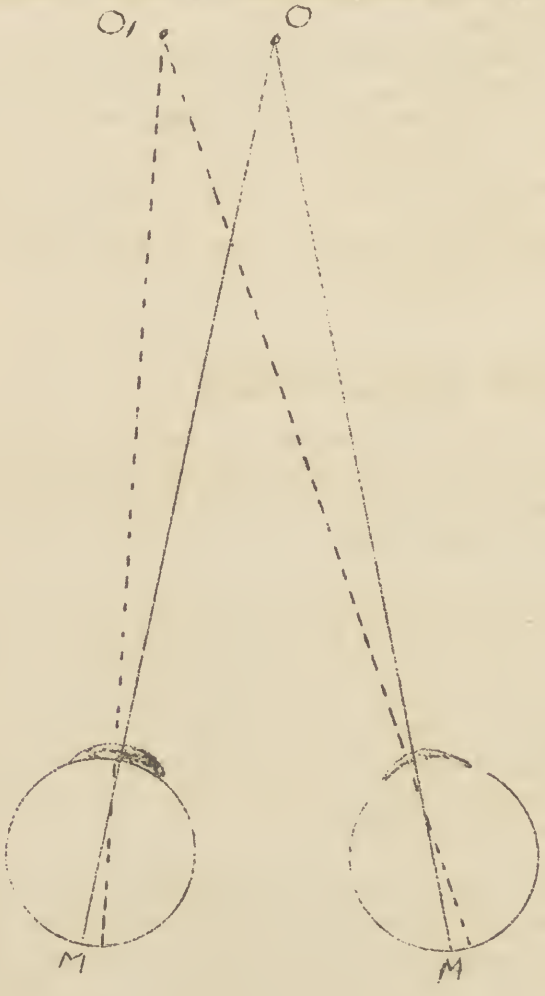
Under ordinary conditions, both eyes are concerned in the action of vision, and are involuntarily adjusted, so that the image of an object is focussed on the macula (most sensitive portion of the retina) of each eye. The two images are fused in the brain into a single mental perception. This faculty constitutes binocular single vision (where an object is seen as one when both eyes are used, which is true with normal eyes, and is controlled by the sense of FUSION.

A simple example and explanation of fusion--if we hold a pencil at arms length in front of our eyes and close the left eye we see the pencil with the right eye. The image of the object is formed on the retina of the right eye. Similarly the image is formed on the retina of the left eye when the right

eye is closed and the left eye is opened. Then if both eyes are held open two images are formed, one on the retina of each eye, however if the eyes are normal we see or perceive only one pencil. This is due to the fact that the two images are fused into one by the fusion center of the brain.

Fusion takes place when both eyes are focused on the object at the same time as illustrated below when the retinal image of the pencil is on the macula of each eye.

Fusion of objects not in direct line with the axes of the eyes takes place when the images fall on corresponding points of the two retinae and a single visual sensation is produced (binocular single vision). See diagram below.



Left Eye

Right Eye

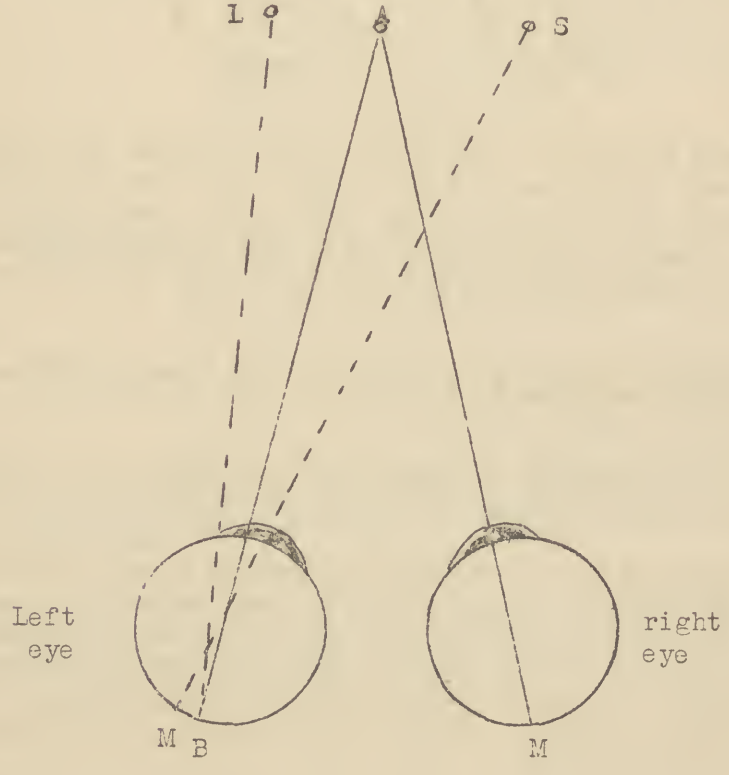
Both eyes focus on object O. Another object O1 is seen as one because rays of light from it fall on corresponding points on the retina--approximately the same distance to the right of macula (M) of each eye.

When the visual lines of the two eyes are NOT directed towards the same object, i.e., when one eye deviates, diplopia or double images result, unless the image of the deviating eye is suppressed (which is usually the case if eyes are crossed or deviate for a long period of time). By suppression we mean the withholding of sight involuntarily, or in other words we mean the individual does not see with the eye.

DIPLOPIA (or double vision) is a derangement of the visual axes where by two distinct impressions are received from a single object and is caused by the image falling on non-corresponding points of the retina.

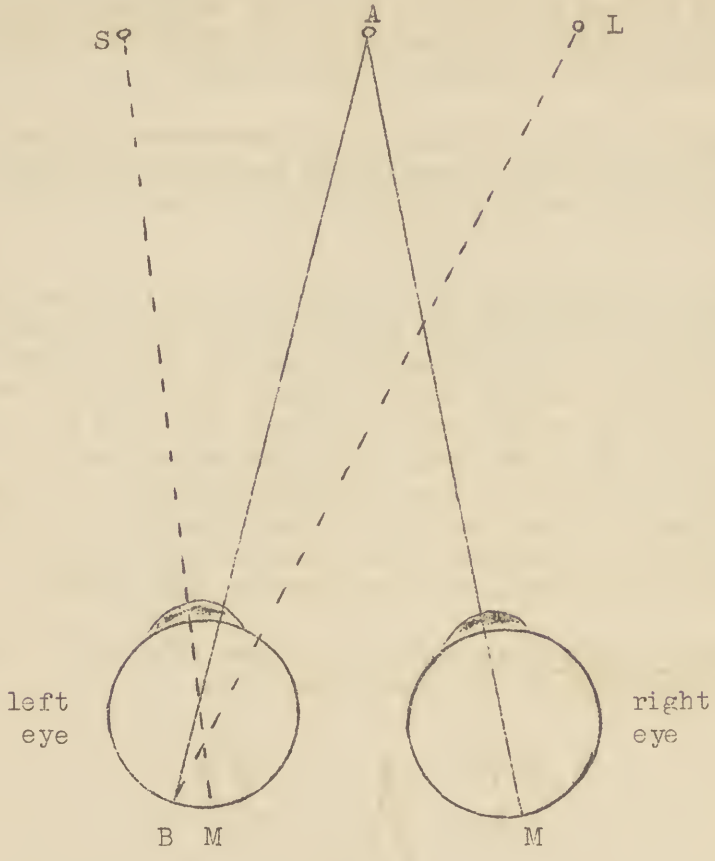
An example of diplopia--if we hold a pencil before our eyes and the visual axis of the left eye is deviated from the object by pressure on the lateral side of the left eyeball with a finger, two pencil images will be seen. The retinal image of the pencil will fall on the macula of the right eye and a little off the macula of the left eye. The image perceived by the left eye (deviating eye) will be less distinct because it is perceived by the peripheral part of the retina (not macula) and is known as the FALSE IMAGE. The image perceived by the right eye (fixing eye) will be distinct and is called the TRUE IMAGE.

HOMONYMOUS DIPLOPIA is where the false image is on the same side of the true image as the deviating eye.



Homonymous diplopia. Right eye is the fixing eye. Rays from object A fall on the macula of right eye, and to the inner side of the macula of left eye--at B. MS is the visual axis of left eye. Image of left eye L is to the left of the object A.

CROSSED DIPLOPIA is where the false image is on the opposite side of the true image from the deviating eye.



Crossed diplopia. Right eye is the fixing eye. Rays from object A fall on the macula M of right eye, and to the outside of the macula of left eye-at B. MS is the visual axis of the left eye. Image of left eye L is to the right of object A. The image L is crossed over to the opposite side from the deviating eye.

HORIZONTAL DIPLOPIA is where the two images (false and true) are on the same level.

VERTICAL DIPLOPIA is where the two images are displaced vertically, i.e. one image is above the level of the other.

ORTHOPHORIA may be defined as perfect muscle balance. There is no tendency for the eyes to deviate even though there is no involuntary fusion effort. There is perfect balance between a muscle and the one acting in an opposite direction. As an example, the right internal rectus is in perfect balance with the right external rectus. These muscles act directly opposite to each other.

HETEROPHORIA is a condition in which the eyes have a constant tendency to deviate, but are forced into simultaneous fixation by muscular effort prompted by the fusion center of the brain, or by the desire for binocular single vision. Ordinarily the deviation is not apparent, hence it is said to be latent (not manifest). The deviation becomes manifest only when fusion control is weakened or abolished. The tendency to deviate is due to over-action or under-action of one or more of the extra-ocular muscles.

The types of heterophoria are:

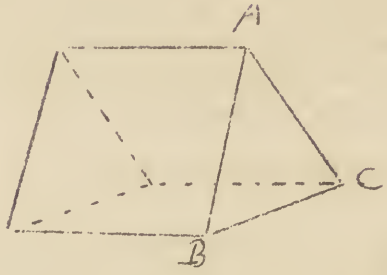
EXOPHORIA is a tendency for the eyes to deviate outward.
ESOPHORIA is a tendency for the eyes to deviate inward.
HYPERPHORIA is a tendency of one eye to deviate upward in relation to the other eye; right hyperphoria is when the right eye tends to deviate upward. This variety of imbalance may be associated with exophoria or esophoria.
CYCLOPHORIA is a tendency of the vertical meridian of one eye to deviate from the vertical position. This condition is seldom seen in aviation personnel and is not determined routinely.
HETEROTROPIA is a manifest deviation of one visual line. One eye is actually deviated from the parallel, even while the fusion centers are presumably working. Other terms for this condition are STRABISMUS and SQUINT (commonly known as cross eyed).

The types of heterotropia are:

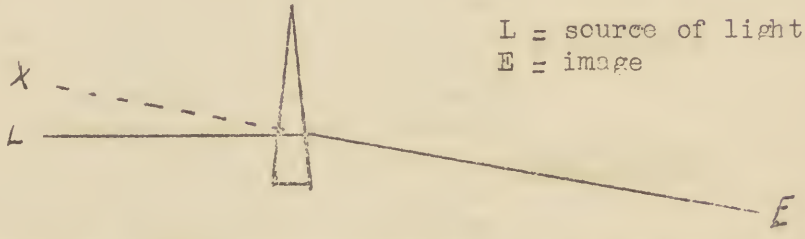
EXOTROPIA is a manifest deviation of the visual lines outward--a divergent squint. Where the deviating eye looks outward when the fixing eye looks straight ahead (in primary position).
ESOTROPIA is a manifest deviation of the visual lines inward--a convergent squint. The eyes are crossed, e.e. where the deviating eye looks inward and the fixing eye is in the primary position (looking straight ahead).
HYPERTROPIA is a manifest deviation of one visual line above the other.

PRISMS--An optical prism is a piece of glass bounded by plane surfaces inclined toward each other. The thin edge, where

the intersecting surfaces meet, is known as the apex (A) and the opposite thick portion as the base (BC).



Rays of light passing through a prism are bent toward the base.

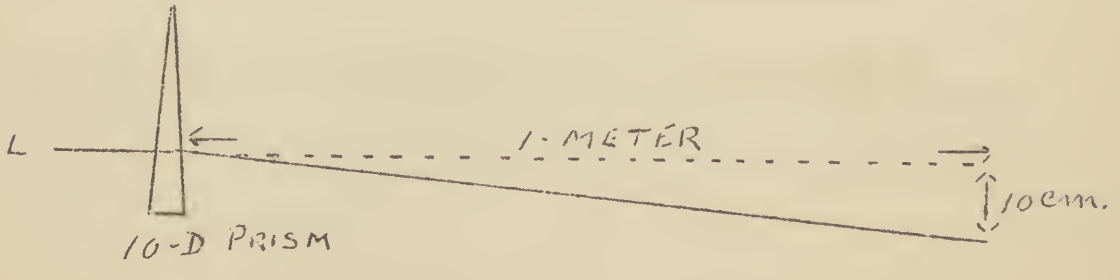


When light rays arise at "L" they pass through the prism and the image is formed at "E" which is towards the base.

If a person's eye were placed at E the light would appear to be at X instead of L, i.e. an object seen through a prism appears displaced towards the apex.

The strength of a prism is usually expressed in prism-diopters, or commonly just diopters.

PRISM-DIOPTER--A prism of one diopter strength will deviate a ray of light one centimeter at one meter distance, or one inch at one hundred inches distance. A prism of 10 diopters will deviate a ray of light 10 Cm at one meter distance.



THE PHOROMETER The term literally means to measure the bearing. It is an instrument for measuring the strength, deviation and direction of the extrinsic muscles of the eye. It is the instrument used in aviation examinations to test for muscle imbalances of the eye. (see picture)

THE RISLEY ROTARY PRISMS are two prisms placed together which can be rotated one against the other. It is a convenient and handy gadget for quickly changing the prism strength in the measuring of the amount of a muscle imbalance. Two prisms of equal value (usually 15 D.) are placed together so that when the base of one is to the apex of the other they neutralize each other and the combined refracting value is zero. If we rotate one against the other until the two bases are together we have a prism equal in value to the sum of the two, i.e., 30 diopters.

2 Prisms placed apex to base. Prism strength is zero, as one Prism neutralizes the other.

2 Prisms placed apex to apex and base to base. Prism strength equals the sum of the two prisms.

If the two prisms are placed together with one base up and the other base down and then rotate one against the other in opposite directions an equal amount--we may get a prismatic effect ranging from zero to the sum of the two prisms (30 diopters).

If the bases of the two prisms are rotated base out we get a base out effect and if basses of both are rotated inward a base-in effect is obtained. Similarly a base up or base down effect may be obtained.

The rotary prisms perform the same function as a set of simple prisms and while a great convenience and time saver it is not essential in the determination of heterophoria. The prisms from a trial lens case may be used quite satisfactorily if a rotary prism is not available.

THE MADDOX ROD (see (L) in picture of phorometer) consists of one or more pieces of colorless (or red) glass rod set in a hard-rubber disc, to fit into the trial frame. It converts the image (spot of light) perceived by one eye into a streak of light, so that there remains a decreased desire to unite it, or fuse it, with the image of the other eye. A strong convex cylinder answers the same purpose. The line of light is always at right angles to the axis of the rod.

The type of rod found on the usual phorometer trial frame is multiple or compound, i.e., several rods with the axes parallel and within the same plane. The multiple rod is easier to adjust in front of the eye because of the larger area involved. The single rod must be placed exactly between the pupil and the spot of light.

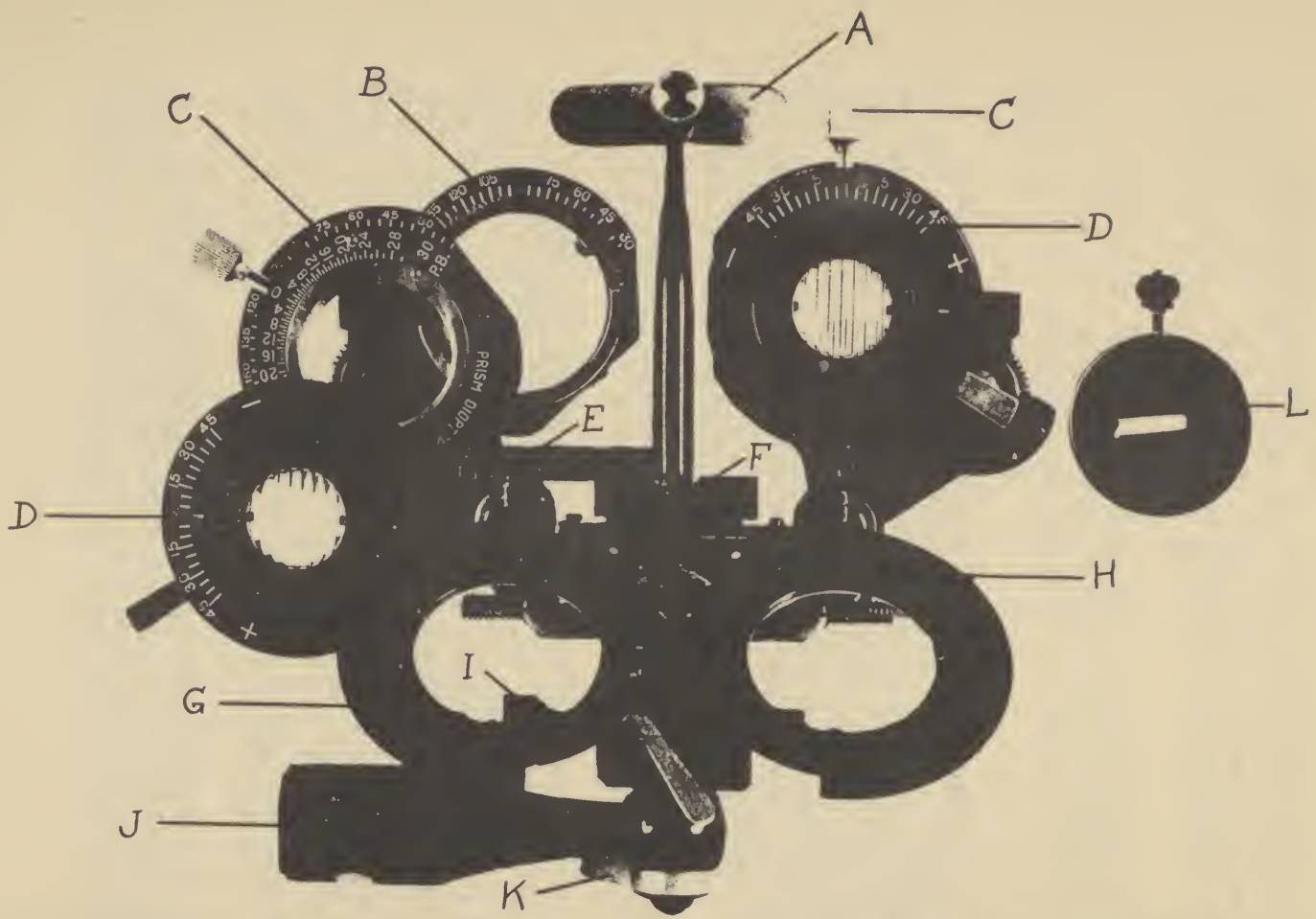
The object of the rod in the phorometer test is to greatly weaken or reduce the tendency to fuse (two dissimilar images issuing from the same source of light). The power of fusion is decreased by changing the shape, size, position or color of the images perceived by the two eyes. The Maddox rod changes the shape of the images and seems to decrease the fusion more than any other method. Some tests employ the factor of different size images for breaking up fusion. This is done by placing a plus lens in front of one eye which magnifies one of the images. The position of one image may be changed by placing a prism in front of one eye, and this is the method used to break up fusion in the Stevens Phorometer. The color of the images may be changed by placing a red lens before one eye. Sometimes a combination of red lens and Maddox rod or a red Maddox rod is employed with probably the best results.

The Maddox rod on the phorometer is used to break up fusion and allows the phorias to become manifest. It actually allows the eyes to deviate if there is an imbalance of the extra-ocular muscles.

THE ROTARY PRISM measures this deviation in terms of prism-diopters.

The actual employment of the Maddox rod and rotary-prism will be given later in this manual.

THE STEVENS PHOROMETER, or Stevens Frame, is the small frame attached to the front part of the phorometer, and may be raised so as to be in front of the eyes or may be lowered out of the way when not in use. It is made of two one-diopter prisms (in some instruments the prism strength is more than one) and set in such a manner that when the one before the left eye is set at zero the one-diopter prism before the left eye is base down and the prism before right eye is base up, making a total of two diopters separation of the images of the two eyes in the vertical position. If there is no lateral phoria (esophoria or exophoria) one light will be directly above the other. When the right prism is set at zero both prisms are base in giving a two diopter base in effect which separates the two images two diopters on the horizontal plane (one beside the other if no hyperphoria is present). The principle involved in this arrangement is that when testing for vertical phorias (hyperphoria) the right prism measures the phoria and the left prism separates the images (spot of light) horizontally and this change of position of the images decreases the tendency to fuse. In testing in this fashion the Maddox rod is not used. And likewise when testing for a mild lateral phoria (esophoria or exophoria up to 2 diopters) the measuring is done with the left prism, and the right prism separates the images (spot of light) vertically and consequently decreases the tendency to fuse.



THE PHOROMETER. A- adjustable forehead rest. B- triple cell trial frame with degree markings for cylinder axes. C- Risley rotary prisms. D- multiple or compound Maddox rod. E- interpupillary distance scale. F- bubble level. G- Stevens phorometer or frame. H- interpupillary distance adjusting thumb screw. I- thumb screw for leveling the apparatus. J- for attachment to phorometer stand. K- for attachment for near work. L- single Maddox rod from trial case.

For all practical purposes we use the Stevens frame to test for hyperphoria, with the aid of the Maddox rod for decreasing fusion, and consider only the prism in front of the right eye. The prism strength, base up or down, is read from the red figures. The prism before the left eye (with white figures) can be completely disregarded in all routine phorometer work since the Maddox rod and rotary prism are available.

THE SIGHTING EYE--when we look at or fix on an object we habitually do so with one eye first, while the other eye adjusts itself to take up fixation after this act has been accomplished by the former. The eye that sights an object first is referred to as the sighting or fixing eye.

As a rule, a right-handed person will sight with his right eye, and a left-handed person with his left. However, this rule is not infallible and too much reliance should not be placed on it.

Assuming that the eye one employs habitually for sighting is the more steady or non-deviating of the two, it is advisable, therefore, when measuring deviations to allow the examinee to sight with the eye customarily employed for that purpose. When this is observed the tests are carried out with the non-sighting eye, as this is the eye that deviates more readily should any deviation occur. In other words the Maddox rod and rotary prism are swung into position in front of the non-sighting eye, and nothing is placed before the fixing or sighting eye.

Investigations have shown that the findings are considerably more consistent and accurate when this procedure is followed.

DETERMINING THE SIGHTING EYE--for determining the sighting eye a black card about 5 x 8 inches in size with a 3/4 inch round hole in the center is employed. The examinee is seated facing the spotlight 20 feet away. He holds the card by the short side with both hands. While looking intently at the light with both eyes open, he slowly raises the card at arm's length and locates the light through the hole. While holding the card still he determines which eye he sees the light with, by closing one eye and then the other. He cannot see the light through the hole in the card with but one eye at a time. The eye he uses to sight the light through the hole is the sighting eye.

IN USING THE PHOROMETER--adjust the apparatus so that the pupils of eyes are on the same level with the center of the triple coil trail frame. It is a good practice to make this elevation adjustment before the phorometer is placed on the

nose and close to the eyes, as some of the instrument stands slip and drop a few inches while being adjusted and there is danger of it striking the examinee's nose causing acute pain.

After proper elevation is secured the cells are adjusted as to interpupillary distance by increasing or decreasing the distance with the proper thumb screw. Likewise the instrument is made level by centering the level bubble with the thumb screw.

For determining an imbalance in the horizontal meridian, exophoria or esophoria, swing the Maddox rod up before the non-sighting eye so that the axis of the rod is horizontal (so as to have a vertical line--running straight up and down). Have a spot light of 1 cm. diameter placed at 20 feet distance, and switch off lights in the vicinity so that the room is dark. Make sure there are no streaks of light showing near the spot light. Direct the examinee to fix, with both eyes open, upon the spotlight, and alternately cover and uncover the non-fixing eye with a piece of card board, allowing the fixing eye to maintain fixation constantly.

The momentary covering of the non-fixing eye aids further in preventing fusion. If this covering is not done properly the eyes try to fuse the images even though they are of different shapes (spot and line), and the full amount of muscle imbalance will not be determined. This covering and uncovering should be as follows: cover for a few seconds and then quickly uncover for just a second and then quickly cover for a few more seconds. Continue this, by just giving the examinee momentary glimpses of the streak of light, until the amount of deviation is determined. Do not allow the uncover-interval to be as much as the cover-interval. This later procedure is an erroneous practice, sometimes followed by individuals who should know.

IF ORTHOPHORIA EXISTS the visual line of the non-fixing eye will not deviate and the vertical line of light will be seen passing through or bisecting the spotlight.

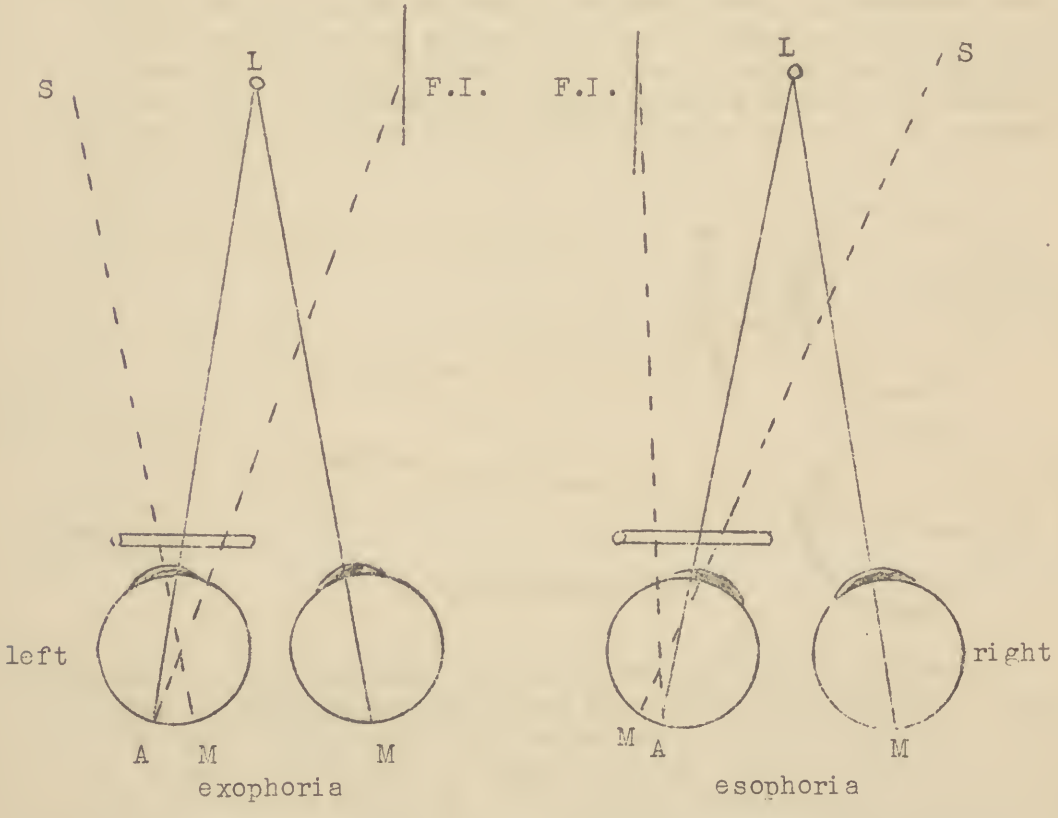
IF HETEROPHORIA IS PRESENT (muscle imbalance--in this case exophoria or esophoria) the vertical line of light will be seen to the right or left of the spotlight.

If the line of light is seen on the same side (homonymous diplopia) of the examinee as the Maddox rod is placed (for example the rod is before the left eye and the line is seen to the left of the spotlight), the diagnosis of esophoria is made, and in order to determine the amount the Risley rotary prism is turned outward, getting a base-out effect. The examinee is shown the thumb screw on the rotary prism and is instructed to turn it like

winding the stem of a watch until the line passes through the spotlight. You need not tell him which way to turn the screw as he will determine this himself by trial and error. This later procedure is carried out while the examiner is covering and uncovering the non-fixing eye.

The reading on the rotary prism, when line is passing through the light, is the amount of esophoria in prism diopters. It is a good practice, at the beginning of the test, to cover the non-fixing eye and ask examinee if he can see the spot of light (sees it with fixing eye), then cover the fixing eye and as k if he sees the line of light. Proceed with the test by covering and uncovering the non-fixing eye while he turns prism to put line through the spot of light.

If the line of light is seen on the opposite, as for example, the Maddox rod is before the left eye and the line is seen to the right (crossed diplopia), then a diagnosis of exophoria is made. To determine the amount the rotary prism will be turned inward (base-in effect). The procedure for determining the amount is the same as with esophoria except the rotary prism will be turned inward when the examinee puts the line through the spotlight, while examiner covers and uncovers the non-fixing eye.

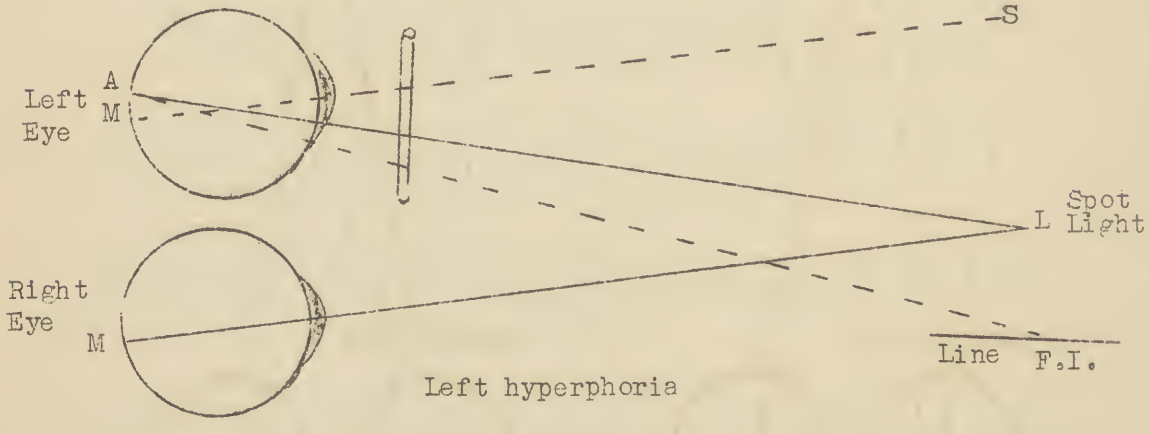


M--macula. SM--visual axis. LA--ray of light that strikes retina to the side of the macula. F.I.--false image or line of light that is projected to one or the other sides.

VERTICAL DEVIATIONS. Ordinarily hyperphoria only (inst ead of hypophoria) is used as a diagnostic term where there exists a deviation of the visual lines in the vertical meridian, and the designation is made as to right or left, depending upon which of the visual lines is the highest. Hypophoria is not used as it is obvious to the student that a right hyperphoria is the same as a left hypophoria, and a left hyperphoria the same as a right hypophoria.

For the measurement of hyperphoria the Maddox rod is adjusted before the non-sighting eye with its axis vertical, so that the line of light is seen in the horizontal position. The non-fixing eye is alternately covered and uncovered, and if the line of light is seen passing through the spot of light there is no hyperphoria. If the line of light is seen below the spot of light there is a hyperphoria of the eye behind the Maddox rod. If the line is above the spot there is a hyperphoria of the fixing eye. If a vertical imbalance is present the examinee should be instructed to work the lever on the Stevens frame up or down until the line p asses through the spot. The amount of deviation is then read from the red figures in front of the right eye.

If a Stevens phorometer attachment is not available the Risley rotary prism may be used instead by rotating it so that the thumb screw points laterally instead of straight up. By turning this screw the horizontal line may be raised or lowered to pass through the spot, getting a base-up or base-down effect. This is less satisfactory than the Stevens frame because when the Risley rotary prism is used it is very difficult to read the amount of deviation in fractions of a diopter. It is of importance to read the vertical phorias in fractions of a diopter.



Left hyperphoria

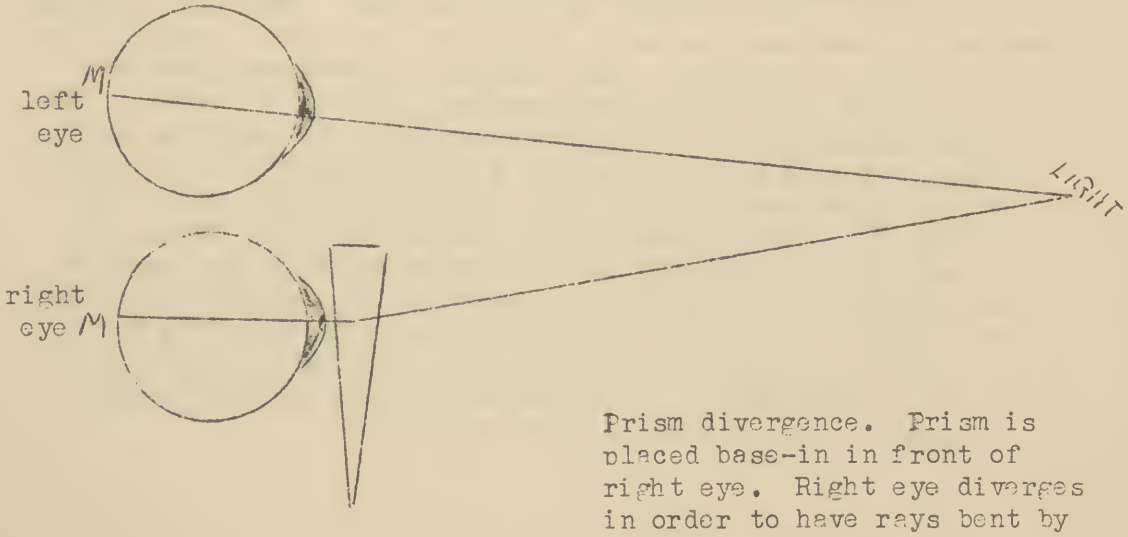
Vertical deviation. The eyes are drawn in vertical section and not in horizontal section as the p revious diagrams. Side view of the eyes with left eye shown above the right. MS is visual axis of left eye. Rays of light LA strike the retina of left eye to the outside of macula--M. The false image F.I. is projected below the spotlight. To measure this a base-down prism before left eye would be used. This prism would bend the line LA to LM--thereby causing rays of light from the spot light to fall on the macula of left eye. Right eye is fixing and rays fall on macula of right eye.

PRISM DIVERGENCE (power of abduction). The normal power of abduction ranges between three and six prism diopters with an average of four. When a low prism divergence is exhibited (below four diopters) associated with an esophoria, it indicates an overaction of the internal recti muscles, or an underaction of the external recti, or both. At the same time the power or urge of the fusion center may be weak.

The examinee is seated facing a spotlight 20 feet away. The rotary prisms of the phorometer are adjusted before one eye so that when the thumb screw on the prisms is turned towards the nose the prisms will be acting base-in. The Maddox rod is not used. With the prisms set at zero on the scale the examinee should see but one spot of light. As the prisms are slowly rotated, base-in, by the examiner, diplopia or double image (two spots of light) will be produced. The number of prism diopters which cause the onset of diplopia is read on the scale and entered on the record as prism divergence.

Do NOT cover and uncover the eye as fusion should not be broken. As the prism strength is increased the eyes continue to fuse the images as long as possible and do so by rotating outward, in order to follow the rays of light that are bent by the prism.

As soon as fusion is broken and two spots of light are seen there is no further tendency to fuse and the eyes assume their normal position. As soon as the light breaks in two the spots jump rather rapidly apart (a good distance if a high prism divergence is present) giving the examinee the impression that he did not detect the break properly, however, the first or second trial is usually correct. More than three trials at one time may make the eyes uncomfortable. The thumb screw should be turned in a steady manner and slowly. The rotary prism may be before either eye, or both, and the eyes need not be squarely up to the frame as long as they are on the same level (one not higher than the other).



Prism divergence. Prism is placed base-in in front of right eye. Right eye diverges in order to have rays bent by the prism fall on macula.

ANGLE OF CONVERGENCE (Power of convergence or power of adduction). The angle is computed from:

Near point of convergence (PcB)

Interpupillary distance (Pd)

The near point of convergence is represented by the symbol PcB (punctum convergens basalis), meaning the near point of convergence to the base line. The measurement is made from an imaginary line connecting the centers of rotation of the two eyes, situated 13.5 millimeters behind the anterior surface of the cornea. The point to be obtained is to determine the greatest amount of convergence that can be exerted and still maintain binocular single vision.

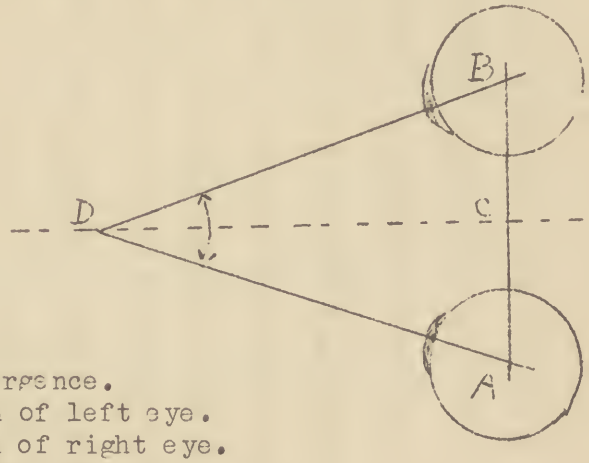
Near point of convergence. The end of the Prince rule, or a modification of same, is placed edge up at the side of the nose eleven and one-half millimeters in front of the anterior surface of the cornea. A white headed pin is held thirty three centimeters in the median line above the edge of the rule, and the examinee is instructed to look at it intently. If both eyes are seen to converge upon the pin, it is then carried in the median line along the edge of the rule, towards the root of the nose. The examinee's eyes are carefully watched, and the instant one is observed to swing outward the limit of convergence has been reached. The point on the rule opposite the pin is then read in millimeters. This test is repeated until a fairly constant reading is obtained. Usually the first or second try is correct and as the trial is repeated the muscles become fatigued and the PcB gradually becomes more remote. To the reading thus obtained twenty five millimeters are added, (the center of rotation is 13.5 mm. behind the cornea and the end of the rule is placed 11.5 mm. in front of cornea making a total of 25 mm.), which gives the distance from the near point of convergence to the base line. The normal eyes should be able to converge to 75 mm. or less. A near point more remote than 75 mm. indicates an underaction of the external recti.

Interpupillary distance. The examiner stands with his back to the light, face to face with the examinee. The rule is laid across the examinee's nose in line with his pupils, as close to the two eyes as possible. The distance is measured from the nasal side of one pupil to the temporal side of the other. The examiner closes his right eye and instructs the examinee to fix his eyes upon his open left. With the eyes in this position a predetermined mark on the rule (preferably zero) is placed in line with the nasal border of the examinee's right pupil. The rule must be held steadily in this position while the examiner opens his right eye and closes his left. The examinee is then instructed to look at the open right eye. The point on the rule in line with temporal border of the examinee's left pupil is read in millimeters. The distance between the two points on the rule is the interpupillary distance.

The following formula is used to compute the angle of convergence: Angle of convergence equals one-half the interpupillary distance multiplied by one hundred, divided by the near point of convergence, plus three, thus:

$$\frac{1/2\ Pd. \times 100}{PcB} \text{ plus } 3 = \text{angle of convergence}$$

The above formula for determining the angle of convergence is purely emperical, and it is not accurate from a standpoint of pure mathematics. It is fairly accurate when PcB and Pd are approximately equal. It is suggested that the table showing the angles of convergence with different findings as to Pd and PcB be used instead, (see table on next page), as this table is computed accurately from tables of tangents.



The angle of Convergence.
A--center of rotation of left eye.
B--center of rotation of right eye.
D--point of maximum convergence.
DC--distance from point of convergence to base line (PcB).
ADB = angle of convergence.
AB--distance between centers of rotation, same as Pd.

ASSOCIATED PARALLEL MOVEMENTS. This test is applicable almost exclusively to paresis and paralysis of the ocular muscles, and offers little information where latent errors are concerned.

The examinee stands near a window where good illumination falls on both eyes. The examiner holds a white headed pin about thirty-three centimeters directly in front of the examinee's eyes and directs him to look at it steadily. Nystagmus in the primary position is to be noted at this stage of the test. The examinee is then instructed to hold his head still and watch the pin as it is moved slowly in the six cardinal positions. Care is taken not to carry the pin beyond the field of binocular fixation. The eyes are inspected to discover any failure in fixing the pin. A lagging or over action of either eye is noted.

TABLE FOR COMPUTING ANGLE OF CONVERGENCE

PcB	PD 56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
	ANGLE																
40	69	71	72	73	74	75	76	76	77	78	79	80	81	82	82	83	84
41	69	70	71	71	72	73	74	75	76	77	78	78	79	80	81	82	83
42	67	68	69	70	71	72	73	74	75	75	76	77	78	79	80	80	81
43	66	67	68	69	70	71	72	72	73	74	75	76	77	78	78	79	80
44	65	66	67	68	69	69	70	71	72	73	74	75	75	76	77	78	79
45	64	65	66	66	67	68	69	70	71	72	72	73	74	75	76	76	77
46	63	64	64	65	66	67	68	69	70	70	71	72	73	74	74	75	76
47	62	62	63	64	65	66	67	68	68	69	70	71	72	73	73	74	75
48	60	61	62	63	64	65	66	67	67	68	69	70	71	71	72	73	74
49	59	60	61	62	63	64	65	65	66	67	68	69	70	70	71	72	73
50	58	89	60	61	62	63	64	64	65	66	67	68	68	69	70	71	72
51	58	58	59	60	61	62	63	63	64	65	66	67	67	68	69	70	70
52	56	57	58	59	60	61	62	62	63	64	65	66	66	67	68	69	69
53	56	56	57	58	59	60	61	61	62	63	64	65	65	66	67	68	68
54	55	56	56	57	58	59	60	60	61	62	63	64	64	65	66	67	67
55	54	55	56	56	57	58	59	60	60	61	62	63	63	64	65	66	66
56	53	54	55	56	56	57	58	59	59	60	61	62	62	63	64	65	65
57	52	53	54	55	56	56	57	58	59	59	60	61	62	62	63	64	64
58	52	52	53	54	55	56	56	57	58	58	59	60	61	61	62	63	64
59	51	52	52	53	54	55	55	56	57	58	58	59	60	61	61	62	63
60	50	51	52	52	53	54	55	55	56	57	58	58	59	60	60	61	62
61	49	50	51	52	52	53	54	55	55	56	57	58	58	59	60	60	61
62	49	49	50	51	52	52	53	54	54	55	56	57	57	58	59	60	60
63	48	49	49	50	51	52	52	53	54	54	55	56	57	57	58	59	59
64	47	48	49	49	50	51	52	52	53	54	54	55	56	57	57	58	59
65	47	47	48	49	50	50	51	52	52	53	54	55	56	56	57	57	58
66	46	47	47	48	49	50	50	51	52	52	53	54	55	55	56	56	57
67	45	46	47	47	48	49	50	50	51	52	52	53	54	54	55	56	57
68	45	45	46	47	48	48	49	50	50	51	52	52	53	54	54	55	56
69	44	45	46	46	47	48	48	49	50	50	51	52	52	53	54	54	55
70	44	44	45	46	46	47	48	48	49	50	50	51	52	52	53	54	54
71	43	44	44	45	46	46	47	48	49	49	50	50	51	52	52	53	54
72	42	43	44	45	45	46	47	47	48	49	49	50	50	51	52	52	53
73	42	43	43	44	45	45	46	47	47	48	49	49	50	51	51	52	52
74	41	42	43	43	44	45	45	46	47	47	48	49	49	50	51	51	52
75	41	42	42	43	44	44	45	46	46	47	48	48	49	49	50	51	51
76	40	41	42	42	43	44	44	45	46	46	47	48	48	49	49	50	51
77	40	41	41	42	43	43	44	44	45	46	46	47	48	48	49	49	50
78	39	40	41	41	42	43	43	44	45	45	46	46	47	48	48	49	50
79	39	40	40	41	42	42	43	43	44	45	45	46	47	47	48	48	49
80	39	39	40	40	41	42	42	43	44	44	45	45	46	47	47	48	48
81	38	39	39	40	41	41	42	42	43	44	44	45	46	46	47	47	48
82	38	38	39	40	40	41	41	42	43	43	44	44	45	46	46	47	47
83	37	38	38	39	40	40	41	42	42	43	43	44	44	45	46	46	47
84	37	37	38	39	39	40	40	41	42	42	43	43	44	45	45	46	46
85	36	37	38	38	39	39	40	41	41	42	42	43	44	44	45	45	46
86	36	37	37	38	38	39	40	40	41	41	42	43	43	44	44	45	45

A lagging of either eye in any of the eight cardinal positions is due to an under action of at least one of the extrinsic muscles. It may indicate a paresis or complete paralysis.

The underaction is recorded by stating which eye lags and in which direction the lagging is observed. In the same way any over shooting of either eye is recorded by stating which eye is involved and in which direction.

If any underaction or overaction is observed with this test the findings are confirmed on the tangent plane.

TANGENT CURTAIN (red lens test). The tangent curtain test is made, as a routine, on all examinees who exhibit a lagging or overshooting of either eye in any of the cardinal positions; when an esophoria of more than four prism diopters, at six meters, is uncovered, or an exophoria of more than two.

Bjerrum's tangent curtain is commonly employed when making this test, but a blackboard or perimeter serves equally as well. A perimeter with an arc sufficiently large to permit a distance of seventy-five centimeters, in all degrees, between it and the eyes of the examinee, is the more accurate.

As tangent curtains are not always available the following directions will enable the Flight Surgeon to construct one should it become necessary.

Any black cotton cloth material sixty by seventy-two inches, and a similar sized piece of sheeting, which has been washed to remove the starch, makes an efficient curtain.

The black piece of material is placed upon the white piece and stitched along the margins, thus making a curtain which is black on the front side and white on the back.

The white side of the curtain is marked off in two inch squares, each square representing a deviation of five degrees at seventy-five centimeters distance. Beginning from a point midway between the lateral margins and thirty inches from the top margin are radiating lines placed at angles of fifteen degrees.

The completed curtain is supported in a frame. A wooden frame may be used, but it is recommended that water or gas piping be employed for its construction.

PROCEDURE WITH TANGENT CURTAIN. Place the examinee comfortably seated seventy-five centimeters from the black side of the curtain sith a red glass in front of the right eye. A pin is placed in the center of the curtain, at the point where the radiating lines meet; the head is so adjusted that when the eyes are directed at the center pin they are on a level with it

and looking straight ahead. A small electric light (ophthalmoscope bulb) is then carried over the surface of the curtain in the six cardinal directions of the muscles' action, and in addition there to straight up and down.

The point where diplopia occurs in each meridian is noted by thrusting a black pin in at the point of the light itself and a light colored pin at the site of the other image. This latter is evidently the false image, and if it is red, it is known that the left eye is fixing, and if it is white, the right eye is fixing. In the majority of cases the examinee fixes with the eye not covered by the red glass.

The plot formed on the curtain, by the pins which have been inserted, is transferred with the aid of the rulings on the back of the curtain to a report form, which is a minature of the curtain. This form serves as a permanent record from which a diagnosis of the muscle or muscles involved can be made.

Whether the diplopia is crossed or homonymous is demonstrated by the side on which the red image appears in relation to the eye before which the red glass is placed.

REFRACTION. The refraction is usually done after the completion of the other portions of the examination. As a rule this examination is not made if the examinee has already been disqualified by some other defect. The aviation technician need not know the optical principles involved nor the actual procedure of a refraction.

The technician should be familiar with the procedure for paralysing accommodation with homatropine drops as set forth in the Manual of the Medical Department (see another section of this manual).

Refractive errors are corrected or measured with plus or minus spheres and plus or minus cylinders, which are types of lenses.

TYPES OF REFRACTIVE ERRORS.

1. Simple hyperopia
   (Corrected by plus spheres.)
2. Simple hyperopic astigmatism
   (Corrected by plus cylinders)
3. Compound hyperopic astigmatism
   (Corrected by plus spheres and plus cylinders)
4. Simple myopia or nearsightedness
   (Corrected by minus spheres)

5. Simple myopic astigmatism
   (Corrected by minus cylinders)
6. Compound myopic astigmatism
   (Corrected by minus spheres and minus cylinders)
7. Mixed astigmatism
   (Corrected by a combination of minus and plus cylinders and is written as a plus sphere and a minus cylinder or a minus sphere and a plus cylinder.)

In writing the correction or refractive error the sign (plus or minus) should always precede the amount of the sphere or cylinder. Some errors are corrected with a sphere only and some require a combination of sphere and cylinder.

The retinoscopic findings will often times be larger than the "cycloplegic acceptance" due to the fact that homatropine will not completely paralyse all the accommodation present.

The axis in degrees should always follow the amount of cylinder.

EXAMPLES OF WRITING REFRACTIVE ERRORS:

plus 1.50 Sph.
or
+ 1.50 S.
or
+ 1.50

plus 1.50 Sph. plus .75 Cyl. Ax. 75°
or
+ 1.50 S. + .75 C. x 75°
or
+ 1.50 + .75 x 75°

minus .50 Sph. minus .25 Cyl. ax. 180°
or
- .50 S. - .25 C. x 180°
or
- .50 - .25 x 180°

plus 1.50 Sph. minus 2.50 Cyl. Ax. 180°
or
+ 1.50 S. - 2.50 C. x 180°
or
+ 1.50 - 2.50 x 180°

It is not necessary to write Sph, S., Cyl., or C. after the strength of the lens as only cylinders are followed by the axis. It is also good form to use x instead of Axis or Ax. after the cylinder strength and before the number of degrees (see above).

THE KEYSTONE TELEBINOCULAR

An additional instrument has been added for conducting tests in flight examinations. It is known as the Keystone Ophthalmic Telebinocular, which is in two sizes, the Model "A", the larger size is for use on large carriers and at large Air Stations. Model "B", which is smaller, is for use on smaller carriers and bases.

This instrument is a specially mounted stereoscope with a set of five test cards for use in determining lateral muscle balance, vertical muscle balance, visual acuity and stereoscopic vision, without recourse to dark room facilities. It is intended as an auxiliary and ready screening test for use in the field, at outlying activities, on board ship and in connection with other standard equipment as a ready and quick means of appraising visual function. In all cases where the visual defects disclosed by the use of this apparatus are of a disqualifying degree, the final determination of any such disqualification shall be by the use of standard equipment, in accordance with existing instructions.

Each telebinocular is provided with a series of five stereographs (test cards) as follows:

1. Test card, visual acuity - right eye with the following code - No.1, V-OD.
2. Test card, visual acuity - left eye with the following code - No.2, V-OS.
3. Test card, test lateral muscle balance with the following code-No.3, MB-LAT.
4. Test card, test vertical muscle balance with the following code-No.4, MB-V.
5. Test card, test stereoscopic vision with the following code - No.5, Ster-V.

The following general instructions are printed on the back of each card as follows:

INSTRUCTIONS

Place all five (5) test cards in the holder in the order of their test numbers. With the examinee's head in contact position with the instrument, alluminate the lamp and proceed with the reading of each test card. As each test card is completed, shift the card to the rear position and proceed with the next, etc.

The Interpretation of Findings:- are printed on the back of each card.

Precautions:- Test cards must be accurately seated in the holder to avoid errors in reading. Allow sufficient time to study each card, to permit of the accommodation of the eye to the test.

SECTION II

EAR, NOSE and THROAT

PAGES 26 - 31 inclusive

THE EAR, NOSE, AND THROAT

Examination of the ear, nose, and throat is a very important part of the examination of the naval pilot. The ear, in addition to its function as the organ of hearing, is the seat of the position sense. Orientation in flight therefore, may be dependent upon normal function of the ear mechanism. Changes in air pressure that occur with changes in altitude while flying, require normal interchange of air between the nasal passages on one hand and the nasal sinuses and ears on the other. If for any reason these structures are so abnormal as to prevent this interchange, the pilot will be seriously handicapped when sudden changes in altitude, are required. With the high performance characteristics, and the ever-increasing mechanical proficiency of present-day aircraft, the pilot must, among other things, therefore, have perfect function of his ear, nose, and throat. Since all of these structures are anatomically closely associated, one is not to be separated from the other. Chronic infection in the throat or tonsils may markedly effect the proper function of the ear and Eustachian tube mechanism. Likewise, abnormalty of the nose may effect the proper function of the ears, sinuses, or throat. The best men physically the aviation examiner and technician can find for flight personnel, will be none too good. The aviation medical examiner must examine these structures carefully for defects, but the technician will be called upon to aid in doing tests of hearing and vestibular function.

THE EAR

The ear consists of three principle parts, the external ear and canal, the middle ear, and the inner ear or labyrinth.

THE EXTERNAL EAR, The pinna or auricle consists of the outer part of the ear and is made up of a cartilagenous framework covered by skin. It acts much as the bell on an ear trumpet, in that it gathers sound waves, and conducts them through the external ear canal to the drum membrane. The external ear canal is made up of bony walls, covered by a modified skin containing numerous wax-secreting glands.

THE DRUM MEMBRANE is the membranous structure separating the middle ear cavity from the external ear canal. It serves to transmit sound waves from the external canal through the small movable ossicles contained in the middle ear cavity, to the receptive nerve endings located in the inner ear. Normally, the drum membrane is gray in color, translucent, and contains several landmarks which may be easily seen on examination. Pathological conditions in the middle ear result in changes in the appearance of the membrane. Thorough examination of the drum membrane is therefore an extremely important part of the aviation physical examination.

THE MIDDLE EAR consists of a small, membrane-lined cavity located in the temporal bone. Its lateral wall is formed largely by the membrane tympani. Anteriorly and medially, the middle ear cavity is directly continuos with the Eustachian tube, which opens into the nasopharynx. If one pictures the middle ear cavity as being similar to that of a long-necked wine bottle, its relationships become more apparent. The bottom of the bottle corresponds to the membrane tympani; and the long neck of the bottle may be compared with the Eustachian tube. The mouth of the bottle corresponds to the pharyngeal opening of the Eustachian tube.

The middle ear contains three small bones or ossicles, the malleus, which is attached to the drum membrane, the incus, and the stapes. The incus is connected with the malleus on one side and the stapes on the other, forming a chain of levers which move when the drum membrane moves. The stapes is the stirrup shaped bone, situated so its foot plate just fills the oval window in the medial wall of the middle ear cavity. This wall forms a partition between the cavity of the middle and inner ear.

Sound waves strike the drum membrane, setting it in motion. This motion is conducted through the malleus and incus to the stapes, whose foot plate sets up waves in the fluid contained in the inner ear.

The middle ear is connected with the numerous irregular cavities of the mastoid above and behind, and through the Eustachian tube with the nasopharynx or upper part of the throat. Thus, infections of the nose, nasal sinuses, and pharynx may easily produce changes in the middle ear. Infection in the m iddle ear may easily extend to the cells of the mastoid.

AERO-OTITIS MEDIA is a condition peculiar to aviators. When the throat, nose and nasopharynx become infected with a cold, the inflammation may extend into the Eustachian Tubes. As a result, the tubes become blocked, preventing equalization of air pressure between the middle ear and throat.

When the aviator ascends in flight, the air of the middle ear expands and forces its way through the Eustachian Tube to the throat. On descent, however, the swollen walls of the tube are drawn together preventing air from reentering the middle ear. This condition results in rupture of blood vessels in the cavity, filling it with bloody serum.

If further flight is not undertaken by the aviator for a few days, the serum will usually be reabsorbed and the swelling of the Eustachian Tube membrane will subside.

THE INNER EAR OR LABYRINTH, consists of an irregular cavity in the temporal bone, situated medial to the cavity of the middle ear. It is separated from the middle ear by the thin, bony partition, mentioned before. The inner ear cavity is filled with a fluid called perilymph in which a delicate membranous sac also containing fluid called endo lymph is suspended. The membranous sac called the membranous labyrinth conforms to a great extent to the irregularities of the cavity.

The membranous labyrinth consists of two parts, an anterior coiled tube known as the membranous cochlea, and a posterior sac from which the semi-circular canals originate. The cochlea contains nerve endings which originate the nerve impulses of hearing. The semicircular canals contain nerve endings which originate the nerve impulses concerned with the position sense.

REMOVAL OF WAX FROM THE EARS. Accumulation of wax in the external ear canal must often be removed before adequate clinical examination may be made. Ear wax or cerumen is secreted continuously by the glands of the external ear canal. It tends to accumulate and harden in time, completely occluding the ear canal.

These accumulations should be removed by irrigation. A solution, made by adding a teaspoonful of sodium bicarbonate to a quart of sterile water at body temperature, should be used for this purpose. To test the correct temperature, a few drops of solution may be placed on the back of the technicians hand.

A rubber bulb syringe or a metal ear syringe may be used. The solution should be drawn up into the syringe, and, before irrigation of the ear canal is begun, the syringe should be turned so that the nozzle is up; then, with pressure on the plunger, the air may be removed before irrigation is begun.

A steady gentle stream is directed well into the ear canal, a pus basin being held by the examinee to catch the solution as it runs out of the ear canal. Irregular, forceful, or intermittent pressure on the plunger should not be used as the drum membrane may be ruptured.

If the impacted cerumen is too hard to be washed out, the examinee may be directed to place several drops of sweet oil (olive oil) in the external ear canal three times a day for two days. After that period the impaction will be softened sufficiently to be removed by irrigation.

A sharp curette should never be used to pick out an impaction of wax. The canal wall or membrana tympani are easily injured. Painful or serious infection may frequently be introduced in this way.

The aviation technician will be expected to carry out tests for hearing acuity and of Vestibular function.

All tests for hearing acuity should be done in a quiet room. If a sound proof room is not available the eye examining room is often satisfactory and examination of hearing may be done at the same time visual acuity is taken.

Hearing tests that may be required are:

1. watch tick
2. whispered voice
3. coin click

These are described in paragraph 1562 Manual of the Medical Department. (see page 54)

The audiometer test for hearing loss is an additional test which may be required. The audiometer is a vacuum tube radio like instrument that is designed to emit various standard tones whose loudness may be controlled. By this test, the weakest intensity for each tone that the examinee is able to hear, may be determined. While the test is more accurate in detecting hearing loss, it requires special equipment that is not at present available on every ship and station.

THE VESTIBULAR TESTS. These tests are used to determine normal function of the examinee's vestibular apparatus. They also give an index of the individual's equilibrium.

SENSE OF BALANCE

Sense of balance depends upon a complex integration of stimuli received by the brain from the vestibular apparatus, the eyes, and the muscles, joints, and tendons of the body.

The tests used to determine the examinee's sense of balance consist of:

1. Romberg test
2. Self-balancing test
3. Barany chair test

The technique of these tests are described in paragraph 1564 Manual of the Medical Department. (see page 55)

NOSE

The nasal passages consist of two narrow passages between the external nasal openings anteriorly and upper part of the throat posteriorly. They are separated one from the other by a medial partition or nasal septum. Connected with the nasal passages by numerous small openings, are the paranasal sinuses. These sinuses form excavated air pockets in the bones of the head, one sinus on each side in the frontal bone above the orbits, one on each side in the maxilla, or cheek bone, called the maxillary

sinus o r antrum, two labyrinths of several small irregular cells one on each side between the orbit and nasal passages. Deep in the head there are two sphenoid sinuses one on each side in the sphenoid bone. The lining membrane of each of the sinuses is directly continuous through its opening with the nasal mucous membrane.

Extending into each nasal cavity from its lateral wall are three scroll like projections of tissue called turbinates. These increase the surface area of the nasal cavity touched by the inspiratory air, increasing the efficiency of the nose in heating and humidifying it, much the same as the fins on an airplane engine cylinder increases the efficiency of its cooling system.

The openings of the nasal sinuses are situated under the turbinates.

The soft tissues of the turbinates are so constructed that they may swell, reducing the size of the air passages. This occurs during infection of the nasal membranes, obstructing the sinus openings and reducing their proper drainage. If the partition or nasal septum deviates from the midline it will reduce or completely occlude the breathing space of one or both nasal passages. Individuals having hay fever, or chronic nasal infection tend to develop enlargements of the soft tissues of the nose called polyps. These mechanically reduce the air spaces of the nose and obstruct the openings of the sinuses.

Any of the above mentioned abnormalities prevent adequate and ready interchange of air between the nasal sinuses and nasal passages with changes in altitude. Therefore, examinees presenting any of these abnormalities must be rejected as physically unfit for aviation duties.

THE THROAT

The throat is divided anatomically into several parts. That part extending above the level of the soft palate and connecting with the back part of the nose is called the nasopharynx. That part which is ordinarily seen upon looking into the mouth is called the oral pharynx. That below the level of the tongue is called the hypopharynx. It communicates with the oesophagus behind and the larynx and air passages in front.

The nasal passages open into the nasopharynx and on each lateral wall may be seen the openings of the Eustachian tubes. On the posterior nasopharyngeal wall there is a mass of lymphoid tissue, called the adenoid.

The tonsils lie on each side of the oral pharynx between two verticle folds called tonsil pillars. Each of these folds contain a small band of muscle covered by mucous membrane. On the posterior oral pharyngeal wall, numerous, small clumps of lymphoid tissue may be seen. These tend to increase in size when chronic infection is present, or when the pharynx is bathed by infected catarrhal discharges from the nose and nasal pharynx.

Chronically infected tonsils may be small and scarred or enlarged, and reddened. The lymph glands draining the tonsil area as well as the nose and throat, are often enlarged when the throat and tonsils are chronically infected. Therefore, the presence of palpable glands below the angle of the jaw on each side of the neck may indicate such infection.

How infections of the nose and throat may affect the efficiency of function of the Eustachian tubes, ears and sinuses has been discussed before. Any individual under examination who has repeated acute inflammation of the throat, or who has evidence of chronic inflammation, should not be accepted for flight duties until these conditions have been rectified.

SECTION III

THE GENERAL PHYSICAL EXAMINATION

AS CONTAINED IN THE MANUAL OF THE MEDICAL DEPARTMENT

(Except for Posture Pictures)

PAGES 33 to 65 inclusive

(Manual of the Medical Department, page 164)

SECTION XXIII. AVIATION, INSTRUCTIONS AND REQUIREMENTS

GENERAL PROVISIONS

1538. Object.--The object of the examination and the instructions incident thereto is to select for flying duty only such officers and enlisted men as are physically and mentally qualified for such duty, and to remove from flying those who may become temporarily or permanently unfitted for such duty because of physical or mental defects. Physical qualifications shall in general conform to the standards prescribed in previous sections.

** 1539. Personnel Requiring the Examination.--

(a) Classification and requirements.-Aviation personnel is divided into ten classes as follows: (1) Naval aviators, (2) student naval aviators, (3) naval aviation pilots, (4) student naval aviation pilots, (5) naval aviation cadets, (6) naval aviators (airship), (7) student naval aviators (airship), (8) naval aviaton observers, (9) naval flight surgeons, (10) unclassified persons ordered to duty involving flying. Classes 1 to 7 inclusive are considered flying personnel and shall take the complete physical examination for flying. For this purpose, class (1) is further divided into flying service groups, based on years of Naval Service for which special physical requirements are prescribed. Classes 8 to 10 inclusive are considered non-flying personnel and shall meet the standard physical requirements for the general service, with such additional physical requirements as are prescribed. The physical requirements for the various flying service groups of class (1), and those for classes 8 to 10 inclusive, as approved by the Bureau of Navigation, are published in Bureau of Medicine and Surgery Circular Letter R, appendix D. When submitting report of physical examination for flying (NMSAv-Form 1), flight surgeons shall state whether any defect noted is considered disqualifying. For procedure in case of disqualification for flying, see Circular Letter R, appendix D.

1543 (a)(3) (b) Eligibility for examination.-The examination shall be limited to members of the aeronautical organization and properly authorized applicants for this service. Applicants shall be given a preliminary physical examination by the local medical officer to eliminate those who obviously cannot meet the physical requirements for aviation.

1540. Restrictions Until Physically Qualified.--

(a) No person should be assigned to duty involving actual flying until he has successfully passed the physical examination for flying prescribed herein, and, except as authorized in subparagraph (d), until official notification has been received from the Bureau that such person is physically qualified for that duty.

(b) Applicant for Aviation Training.-An applicant (commissioned or enlisted) for aviation training shall be given the physical examination for flying, unless he has been examined within 6 months, before being assigned to duty involving flying. When an applicant for aviation training is not in the vicinity of one 1543 (b) of the ships or stations where the physical examination for flying can be made he will be examined in accordance with the instructions governing the examination of candidates for commission and will be expected to meet the standards set forth as acceptable for a commissioned officer. Before being assigned to duty involving flying under training as a pilot, he will be given the complete physical examination for flying at the station to which he may be attached for training.

(c) Naval Reserve.-Pilots of the Naval Reserve who apply for permission to pilot naval aircraft shall be subjected to the 1542 (a) examination prescribed herein unless they present satisfactory evidence that they have passed such examination within six months of the date on which flight is desired.

(d) Pending receipt of approved copy of record of physical examination (par. 1545), or certificate from the Bureau that the 1542 (b) record of physical examination has been approved, personnel may be considered physically qualified if an authorized medical examiner (par. 1544) certifies that the applicant has no physical or mental defect that would disqualify him for flying.

1541. Reexamination; Physical Incapacity.—

(a) A reexamination of any individual shall be made whenever considered necessary by the Bureau, the Bureau of Aeronautics, or by the commanding officer to determine his physical fitness to continue flying duty or flying training.

(b) Upon recommendation by the flight surgeon, the commanding officer may relieve from flying duty or suspend the flying training of any individual reported physically incapacitated. When the individual is reported physically fit again by the flight surgeon, the commanding officer may authorize resumption of such duty or training.

* (c) Aviation personnel of classes 1 to 7 inclusive (par. 1539), upon reporting for duty at a new ship or station, or upon reporting for duty following absence due to serious injury or illness, or upon return to duty from a protracted leave of absence, or when otherwise indicated, shall be given such physical examination as may be required to determine their physical fitness to resume their flying duty.

** 1542. Annual Physical Examination.—

All aviation personnel listed in classes 1 to 7 inclusive in paragraph 1539 shall be required to undergo the complete physical examination for flying annually in accordance with instructions incorporated in the current general order and bureau instructions governing conduction of annual physical examinations. In the case of commissioned officers, this examination shall supplant the annual physical examination as set forth in paragraph 1520. Nonflying personnel in classes 8 to 10 inclusive not serving as pilots, but who are performing flying duty, shall, in addition to the annual physical examination prescribed for the general service, meet the additional special requirements prescribed in Circular Letter R of appendix D. Reports of the physical examination of personnel listed in classes 1 to 9 inclusive, shall be submitted on NMSAv-Form 1.

1543. Examination, Where Made.—

(a) Equipment and personnel for conducting the physical examination for flying have been established afloat and ashore in accordance with the following detailed plan. (For detailed list, see Circular Letter R, appendix D.)

(1) Forces afloat.--Aboard aircraft carriers and the large aircraft tenders at fleet air bases and within certain flag commands to which staff flight surgeons are attached.

(2) Forces ashore.--At naval air stations, Navy and Marine Corps air bases, Navy and Marine Corps reserve Aviation bases and other shore activities and commands within the cognizance of the commandants of the several naval districts, to which flight surgeons are attached and so serving.

1544. Examination, by Whom Made.--

The physical examination for flying shall be made only by medical officers who, after a special course of instruction, are qualified to conduct such examination. There are two groups of medical officers qualified to conduct the physical examination for flying:

(1) Flight Surgeons, who have qualified by taking the basic course in aviation medicine followed by additional indoctrinal flight training.

(2) Aviation Medical Examiners, who have qualified by taking the basic course in aviation medicine but have not received indoctrinal flight training.

RECORDS

1545. Records.--

A record of the physical examination for aviation duty prescribed herein shall be made on NMSAv-Form 1. This report shall be prepared and disposition made in accordance with instructions in Circular Letter R, Appendix D of this manual.

1546. Transfer of Records.--

Whenever an individual is transferred from one ship or station to another, the certified copy of his current NMSAv-Form 1 shall be forwarded to the medical officer of his new ship or station.

1547. Inspection of Records.--The physical examination records of aviation personnel in classes 1 to 7 inclusive shall be inspected by the medical officer annually at the end of January. If a record is missing or incomplete in any particular, the medical officer shall so inform the commanding officer who shall direct the individual to report to the medical officer for the necessary examination to complete his record.

1565 1548. General Examination.-

(a) Except as modified by this paragraph, the general physical examination and general physical standards shall be the same as those prescribed for the general service.

(b) History.- A history of any of the following should be considered as disqualifying:

Syphilis.
Repeated attacks of hay fever or asthma.
Recent attacks of malaria.
Paroxysmal tachycardia.
The presence of any organic heart disease.
Recurrent attacks of any of the rheumatic group.
Renal calculus (recent).
Encephalitis lethargica, or any illness accompanied by diplopia and lethargy.

(c) Height and Weight.- The minimum height for enlisted men is 64 inches. In the case of officers and examinees who may be subject to commissioning, as in the case of aviation cadets, the minimum height requirement is 66 inches.* The maximum height is 76 inches. The minimum acceptable weight for aviation is 124 pounds. The maximum weight is 200 pounds. If the examinee is a subject for commission the minimum weight is 132 pounds.* Individuals shall be well proportioned and shall be near the weight for height as given in the table in section VL. It is particularly necessary for examinees whose weight is near the maximum or the minimum requirement to conform closely to the prescribed ration of height and weight for age.

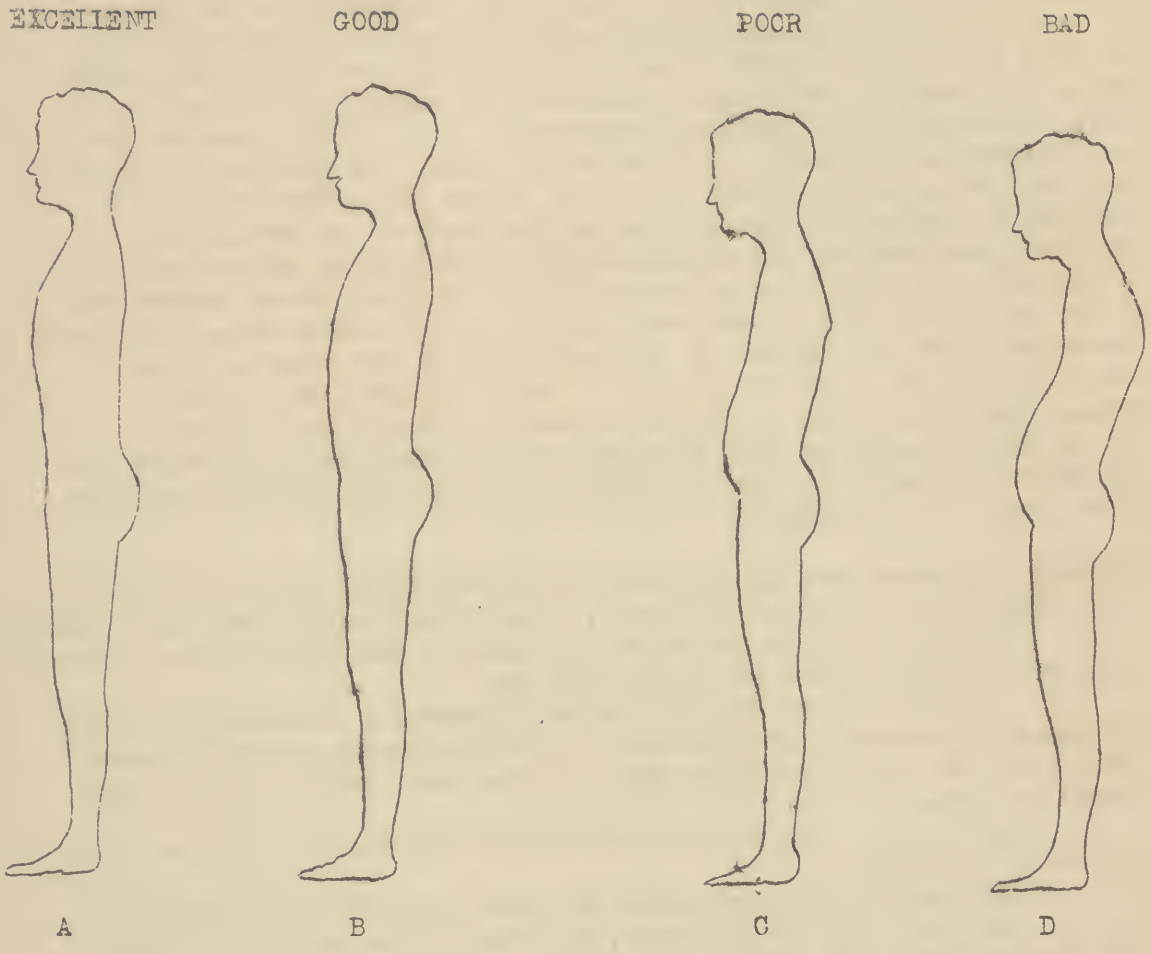
(d) Chest.- Any condition that serves to impair respiratory function may be the cause for rejection. The examinee, if an average sized individual, should normally have not less than 3 inches of expansion. A variation of one-half inch is allowable if the individual is otherwise acceptable.

(e) Cardiovascular System.- Any cardiac arrythmia or heart murmur or other evidence of cardiac abnormality shall be the cause of careful study, including recourse to an electro cardiographic examination when indicated. Any evidence of heart disease shall be cause for rejection.

* (Note) For cadets V-5, minimum height is 64 inches and minimum weight 124 lbs. (See BuNav. Bulletin No. 293 of 7-1-41.)

HEIGHT, WEIGHT & CHEST STANDARDS
FOR
OFFICERS, N.A.C. CANDIDATES & ENLISTED MEN

AGE:	HEIGHT	STANDARD WEIGHT	MAXIMUM WEIGHT	MINIMUM WEIGHT	CHEST	EXPANSION
	65 and under 68	119	137	104	32	2
	68 and under 70	124	142	109	32 1/2	2 1/2
18	70 and under 72	130	149	115	32 1/2	2 1/2
	72 and under 74	135	154	120	33 1/2	2 1/2
	74 to 76	142	163	127	34 1/2	2 1/2
	65 and under 68	124	142	109	32 1/2	2
	68 and under 70	129	148	114	33	2 1/2
19	70 and under 72	135	155	120	33 1/2	2 1/2
	72 and under 74	140	161	125	33 1/2	2 1/2
	74 to 76	145	167	130	34 1/2	2 1/2
	65 and under 68	129	148	114	32 1/2	2
	68 and under 70	134	154	119	33	2 1/2
20	70 and under 72	140	161	125	33 1/2	2 1/2
	72 and under 74	148	170	133	34 1/2	2 1/2
	74 to 76	153	176	138	35 1/2	2 1/2
	65 and under 68	136	156	121	33	2
	68 and under 70	148	170	133	33 1/2	2 1/2
21	70 and under 72	152	176	138	34	2 1/2
	72 and under 74	157	181	142	35	2 1/2
	74 to 76	162	186	147	35 1/2	2 1/2
	65 and under 68	141	162	126	33	2
22	68 and under 70	153	176	138	33 1/2	2 1/2
to	70 and under 72	157	181	142	34	2 1/2
25	72 and under 74	162	186	147	35	3
	74 to 76	168	193	153	35 1/2	3
	65	137	158	122	33	2
	66	141	162	126	33 1/2	2 1/2
	67	145	167	130	33 1/2	2 1/2
	68	149	171	134	34	2 1/2
26	69	153	176	138	34 1/2	2 1/2
to	70	157	181	142	34 1/2	3
29	71	162	186	147	34 3/4	3
	72	167	192	152	35	3
	73	175	201	160	35 1/2	3
	74	182	209	167	35 1/2	3
	75	190	219	175	36	3
	76	200	230	185	36	3
	65	140	161	125	33	2
	66	144	166	129	33 1/2	2 1/2
	67	148	170	133	33 1/2	2 1/2
	68	152	175	137	34	2 1/2
30	69	156	179	141	34 1/2	2 1/2
to	70	161	185	146	34 1/2	3
34	71	166	191	151	34 3/4	3
	72	172	198	157	35	3
	73	178	205	163	35	3
	74	188	216	173	35 1/2	3
	75	195	224	180	35 1/2	3
	76	200	230	185	36	3



A - Excellent Posture. Head up, chin in, head balanced above shoulders, hips and ankles. Chest up, breast bone the part of body farthest forward. Lower abdomen in, and flat. Back curves within normal limits.

B - Good Posture. Head slightly forward. Chest slightly lowered. Lower abdomen in, but not flat. Back curves slightly increased.

C - Poor Posture. Head forward. Chest flat. Abdomen relaxed (part of body farthest forward), back curves exaggerated.

D - Bad Posture. Head markedly forward. Chest depressed (sunken). Abdomen completely relaxed and protuberant. Back curves extremely exaggerated.

(f) Blood pressure and Pulse Rate (circulatory efficiency test).- In considering the blood pressure due regard must be given to the age of the examinee and to physiological causes, such as excitement, recent exercise, and digestion. The condition of the arteries, the tenseness of the pulse, and the degree of accentuation of the aortic second sound must be taken into consideration, as will also the relation between the systolic and diastolic pressures. No examinee will be rejected as the result of a single reading. When the blood pressure estimation at the first examination is regarded as abnormal, or in case of doubt, the procedure will be repeated twice daily (in the morning and in the afternoon) for a sufficient number of days to enable the examiner to arrive at a definite conclusion. In conducting the circulatory efficiency test (Schneider index), the examinee shall be afforded every opportunity to relax. Loud noise, conversation, and other distracting influences which may serve to excite or adversely affect the examinee, are to be avoided. The test should not be taken within 2 hours after a meal. Smoking, fatigue, and intercurrent infections will affect the score. To conduct the test the subject reclines in a quiet environment for not less than 5 minutes, following which the examination proceeds as follows:

METHOD: (1) Heart rate is counted for 20 seconds. When two consecutive 20-second counts are the same, this is multiplied by 3 and recorded.

(2) The systolic pressure is taken by auscultation and recorded. Take two or three readings to be certain.

(3) The subject then rises and stands for 2 minutes to allow the pulse to assume a uniform rate. When two consecutive 15-second counts are the same, multiply by 4 and record. This is the normal standing rate.

(4) Standing pulse minus the reclining pulse gives the increase on standing.

(5) The systolic pressure is taken as before and recorded.

(6) Timed by a stop watch, the subject steps upon a chair 18½ inches high, five times in 15 seconds. To make this uniform, the subject stands with one foot on the chair at the count of one. This foot remains on the chair and is not brought to the floor again until after count 5. At each count he brings the other foot on the chair and at the count "down" replaces it on the floor. This should be timed accurately so that at the 15-second mark on the stop watch, both feet are on the floor.

(7) Start counting the pulse immediately at the 15-second mark on the stop watch and count for 15 seconds. Multiply by 4 and record.

(8) Continue to take pulse in 15-second counts until the rate has returned to the normal standing rate. Note the number of seconds it takes for this to return and record. In computing this return count from the end of the 15 seconds of exercises to the beginning of the first 15-second pulse count. If the pulse has not returned to normal at the end of 2 minutes record the number of beats above normal and discontinue counting.

(9) Check up points and enter final rating as indicated in the table. If after repeated tests the circulatory efficiency rating be seven or less, it is considered sufficient to disqualify.

(10) Enter history of case, including amount of sleep, amount of smoking, kind of work (outdoor and indoor, active or sedentary, etc.), time since last meal, any personal worries, or any pathological condition which might affect the condition of the subject.

* INTERPRETATION OF FINDINGS: Blood Pressure:- If the examinee is a candidate for flight training, the systolic blood pressure shall not persistently exceed 135mm, nor the diastolic pressure exceed 90 mm. In the case of qualified pilots, if the examinee is over 25 years of age, the systolic blood pressure shall not persistently exceed 150 mm. If the examinee is 25 years of age or younger, the systolic pressure shall not persistently exceed 140 mm. A systolic blood pressure of less than 105 mm. disqualifies. A diastolic blood pressure persistently above 95 mm. is disqualifying. Abnormally low diastolic blood pressure should be viewed with concern, particularly with regard to its effect on vasomotor tone while flying. In such cases the underlying cause should be determined if possible. The condition, if sufficiently marked, may be considered as disqualifying.

CIRCULATORY INDEX: This index shall be regarded as a valuable check on the physical condition of the examinee. An index below 8 will be regarded as unsatisfactory. No individual shall be rejected because of a single failure to pass the test satisfactorily, but shall be recalled for further observation and study. Where the index is persistently below the acceptable limit and is indicative of neurocirculatory asthenia, or other abnormalities of the circulatory system, the examinee shall be disqualified.

(g) Teeth.- Evidence of marked malocclusion, especially when associated with a weak or defective dental arch, or with evidence of extensive caries or loss of teeth, shall be cause for rejection.

PULSE RATE INCREASE-ON-STANDING

RECLINING PULSE RATE		0-10 beats	11-18 beats	19-26 beats	27-34 beats	35-42 beats
	Points	Points	Points	Points	Points	Points
50-60	3	3	3	2	1	0
61-70	3	3	2	1	0	-1
71-80	2	3	2	0	-1	-2
81-90	1	2	1	-1	-2	-3
91-100	0	1	0	-2	-3	-3
101-110	-1	0	-1	-3	-3	-3

STANDING PULSE RATE		PULSE RATE INCREASE IMMEDIATELY AFTER EXERCISE				
		0-10 beats	11-20 beats	21-30 beats	31-40 beats	41-50 beats
	Points	Points	Points	Points	Points	Points
60-70	3	3	3	2	1	0
71-80	3	3	2	1	0	0
81-90	2	3	2	1	0	-1
91-100	1	2	1	0	-1	-2
101-110	1	1	0	-1	-2	-3
111-120	0	1	-1	-2	-3	-3
121-130	0	0	-2	-3	-3	-3
131-140	-1	0	-3	-3	-3	-3

RETURN OF PULSE RATE TO STANDING NORMAL AFTER EXERCISE		SYSTOLIC PRESSURE STANDING COMPARED WITH RECLINING--	
SECONDS	POINTS	CHANGE IN MM	POINTS
0-30	3	Rise of 8 or more	3
31-60	2	Rise of 2-7	2
61-90	1	No rise	1
91-120	0	Fall of 2-5	0
After 120:2-10 b eats above normal	-1	Fall of 6 or more	-1
After 120:11-30 beats above normal	-2		

(h) Nervous System.--

(1) Neuropsychiatrical Examination.--Following the completion of the general examination, the examiner shall make a careful study of the examinee's family history for evidence of insanity, familial traits of psychoneurotic manifestations, degenerations, and inherited deficiences. The examinee's personal history shall be searched for significant factors which relate to the formative years that affect his personality trend. The infantile period shall be searched for evidence of retardation. Consideration shall be given to examination of the family life, play life, school life, sex life, and a careful search for epileptic equivalents. Determine the family attitude toward flying and the examinee's reaction to the stresses of life and his general emotional response and control. The object of the examination shall be to determine the individual's basic stability and capacity to react favorably to the special stresses encountered in flying. This phase of the examination will be performed routinely only on applicants for flight training who are otherwise physically qualified.

(2) Neurological Examination.--A careful neurological examination shall be made, careful attention being given to the following examinations and report of findings:

Pupils - Regular, irregular, equal, unequal, do or do not react to light and accommodation.

Deep sense (Romberg) - Negative, slightly positive, or pronouncedly positive.

Deep reflexes--Patellar, biceps, etc. - Absent (0), diminished (-), normal (+), hyperactive (++), and exaggerated (+++).

Superficial reflexes - Abdominal, cremasteric, etc. - Any abnormalities found.

Sensory disturbances - Any abnormalities found.

Motor disturbances - Evidence of muscle weakness, paresis or any other abnormality.

Trophic disturbances - Evidence of atrophy, compensatory hypertrophies or any other abnormality.

Tremors - State whether fine or course, and name parts affected.

Tics - Specify parts affected.

Cranial nerves - Examine carefully for evidence of impaired function or paresis. It should be remembered that some of the cranial nerves are subject to frequent involvement in a number of important diseases such as syphilis, meningitis, encephalitis lethargica, and injuries to cranium.

Any abnormalties disclosed on the neurological examination should be carefully studied and an opinion expressed as to their cause and significance and as to whether they are sufficient cause for rejection.

(3) Psychomotor tension.-Ability to voluntarily relax. Tested by having examinee rest forearm upon palm of examiner and then testing the tendon reflexes of forearm with percussion hammer. The flight surgeon should keep himself informed regarding all indications of staleness in order to recognize the earliest manifestations of that condition.

(4) Peripheral circulation.-Examine for flushing, mottling, and cyanosis of face, trunk, and extremities. Question as to the presence of localized sweating (armpits and palms) and cold extremities.

* (i) Aeronautical Adaptability.-After the examination has been completed, the examiner shall make an assessment of the individuals qualifications for flying, based upon the physical findings and the result of the neuropsychiatric examination. While no individual will possess all good traits, or all bad ones, the examiner will summarize his impressions of the individual's aeronautical adaptability, which shall be recorded as favorable or unfavorable. Where an individual is found to be physically qualified but his aeronautical adaptability is regarded as unfavorable, the entry of findings on NMSAv-Form 1, as finally recorded, shall be "Physically qualified but not aeronautically adapted".

1549. Visual Acuity -

(a) Apparatus and Set-Up.-Five Snellen test charts, each with a different arrangement of letters, and a blank card about 6 by 9 cm. Four test charts are cut off so that only the 20-foot and successive smaller rows of letters are used. The central chart is left fully exposed. The five charts are arranged in close formation against a neutral-colored wall at the end of the examining room and each is numbered. The numerals must be distinctly visible at a distance of 20 feet. Two 100-Watt daylight Mazda lamps with reflectors are installed about 4 feet above and in front of the test charts to provide uniform illumination. A single 200-Watt daylight Mazda lamp in a suitable reflector may be substituted for the above. The switches controlling these lamps and the spot light used with the phorometer trail frame should be located on the side wall, where they can be reached easily by the examiner as he stands beside the examinee's chair. All windows and other sources of light located in front and to the side of the examinee are shaded during the examination.
* Other standard appliance acceptable to the Bureau for testing visual acuity may be used in lieu of the apparatus described above.

(b) Procedure.-Immediately upon entering the room the examinee occupies a chair facing the test charts exactly 20 feet away. In order to prevent study of the letters, the test is begun promptly. The examiner stands at one side of the examinee, using the 6 by 9 cm blank card to cover the left eye while the right is being tested. Designating one of the small charts by number the examiner instructs the examinee to read as many letters as possible. When the best vision for the right eye has been obtained, the card is shifted to cover the right eye and the left eye is tested on one of the other small charts. The large (complete) chart is used only when the vision is less than 20/20. The row of smallest letters read correctly determines the numerator of the fraction used in recording visual acuity. The number of smaller letters read in the next line is added to this fraction following the plus sign; e.g., 20/20 + 4.

(c) Precautions.-Every possible safeguard is thrown around the test to prevent memorizing the charts. Examinees awaiting their visual acuity test are not permitted to remain in the room within sight of the test letters nor where they can hear them read aloud. When the examinee is suspected of having memorized the charts, the examiner will select letters in the doubtful lines and have the examinee name them. The small charts should be given a different arrangement from time to time in order to prevent memorizing the letters according to the position of the charts on the wall. One eye is completely screened from the letters while the other is being tested. The use of the hand or of an opaque disk from the trial case as a screen does not insure a monocular test.

** (d) Interpretation of Findings.-(1) On original examination for flight training: The minimal visual requirement for each eye is 20/20. (2) For qualified and experienced pilots: In the case of qualified pilots visual acuity of not less than 15/20 for each eye unaided by glasses may be permitted where the pilot's experience is sufficient to compensate for this departure from normal vision.

* 1550. Depth Perception at 6 Meters.--

(a) Apparatus.-Depth perception apparatus may be obtained from the Navy Medical Supply Depot on approved requisition. The apparatus shall be installed in such manner as to receive adequate illumination without the examinee being subjected to the direct glare of the light.

(b) Procedure.- The rods in the box are widely separated by the examiner and the examinee is required to manipulate the two cords as to bring the movable rod beside the fixed one in such position that both appear to be the same distance from him. The test is repeated several times, the rods being widely separated before each trial. The examinee's estimation of depth difference is read in millimeters directly from the scale and entered on the record. The test will be conducted at a distance of 20 feet.

(c) Precautions.-No information concerning the results of the successive trials will be given the examinee until after the test is completed. The examinee is required to hold his head straight and not to one side of the other. Care will be taken by the examiner to avoid casting a shadow on the background, to avoid placing the hands so as to give the examinee information as to his error, and to avoid any facial expression from which the examinee might gain information as to the result of his efforts.

* (d) Interpretation of Findings.-An average depth difference of more than 30 mm in five readings disqualifies. An erratic result will necessitate an examination the following day and if still erratic will disqualify until consistently below 30 mm.

1551. The Maddox-rod Screen Test at 6 Meters.--

(a) Apparatus - A phorometer trial frame equipped with a pair of multiple Maddox rods and a pair of Risley rotary prisms, a blank card about 6 by 9 cm, which serves as a screen, and a blank card about 13 by 20 cm, with a 3-cm hole in its center.

(b) Procedure.-Before beginning the test the examinee's fixing eye is determined. For this purpose the 13 by 20 cm card is employed. The examinee seated, facing the spot light 6 meters away, grasps the card by the long sides with both hands. While looking intently at the light he slowly raises the card at arm's length and locates the light through the hole without closing either eye. Only one eye can see the light through the hole, and the eye selected for this purpose is the one used habitually for sighting or fixing.

The phorometer trial frame is now properly leveled and adjusted closely in front of the examinee's eyes. One of the multiple Maddox rods is swung into position before the nonfixing eye. A rotary prism is placed before the same eye. The sighting or fixing eye must have an unobstructed view of the spot light. For the measurement of esophoria or exophoria, the Maddox rod is adjusted before the nonsighting eye to give a vertical line of light. The rotary

prism is adjusted also before the nonsighting eye for the measurement of lateral deviation and set 4 or 5 prism diopters off the zero mark. This gives enough deflection at the first reading to detect an examinee who has been coached to say the line passes through the light.

The 6 by 9 cm card is moved from one eye to the other a few times to ascertain if the examinee sees both the line and the light. If the line is not seen readily, the Maddox rod is readjusted by centering it carefully in front of the pupil. Some further darkening of the room may be necessary to render it clearly visible.

When the examinee sees the line with one eye and the light with the other, the examiner holds the card or screen in front of the nonfixing eye to shut out the image of the line. The examinee now sees only the light. After he has fixed it for several seconds, the screen is removed for an instant and quickly replaced. In that brief interval the examinee will be able to see the line and locate it in reference to the light. After one or two such exposures, he will say that the line is to the right or left of the light or possibly through it. He is instructed to grasp the milled head that rotates the prism and turn it to bring the line directly into the light. To enable him to do this, the screen is removed from the eye at intervals and quickly replaced. Finally, the examinee will have rotated the prism enough to cause the line to pass through the light every time the screen is removed. The number of prism diopters necessary to do this is read from the scale of the rotary prism. This is entered on the record as esophoria if the prism base is out, and exophoria if the prism is base in. For the measurement of hyperphoria, the Maddox rod before the nonfixing eye is readjusted to give a horizontal line of light. The rotary prism is also readjusted before the same eye to measure vertical deviation. The screen is used exactly as before to give an occasional glimpse of the line. The number of prism diopters read from the scale is recorded as right hyperphoria if the prism is base down before the right eye, or base up before the left eye. It is recorded as left hyperphoria if the prism is base up before the right eye or base down before the left. in testing for hyperphoria, the Stevens' frame, which is normally a part of the phorometer mechanism, should be used instead of the large prisms. The Stevens' frame attachment is composed of weaker prisms which are calibrated in tenths of a diopter and therefore permit more accurate readings for hyperphoria.

(c) Precautions.--The Maddox rod and the measuring prism are used always together before the nonfixing eye and never before the fixing eye. The test gives an inaccurate result if the examinee is permitted to see the line for a longer time than is allowed by the momentary flash exposures described above.

(d) Interpretation of Findings.-Esophoria of more than 4 D., if associated with a prism divergence of less than 4 D., disqualifies. Esophoria of more than 10 D., disqualifies even if unassociated with any other visual defect. Exophoria of more than 5 D. disqualifies. Hyperphoria of more than 1 D. disqualifies. When the findings in the test for heterophoria exceed the maximum normally allowed, the red lens test shall be made for evidence of diplopia.

1553 1552. Prism Divergence.--

(a) Apparatus.-Phorometer trail frame and spot light 1 cm in diameter.

(b) Procedure.-The examinee is seated facing the spot light 20 feet away. The rotary prism of the phorometer trial frame is adjusted before one eye so that by turning the milled head the prism will be acting base in. With the prism set at zero on the scale, the examinee should see but one spot of light. As the prism is slowly rotated base in, diplopia will be produced. The number of prism diopters which causes the onset of diplopia is read from the scale and entered on the record as prism divergence.

(c) Precautions.-The test cannot be made if the examinee has diplopia when the prism is set at zero on the scale. If this condition obtains, the examinee is disqualified.

(d) Interpretation of Findings.-Where there exists an esophoria at 6 meters, the prism divergence shall equal or exceed the esophoria in prism diopters. Prism divergence of more than 15 d. or less than 2 D. disqualifies without further evidence.

1553. Red Lens Test.--

(a) Apparatus.-Spectacle trial frame;red lens from trial lens case; small light, such as ophthalmoscope without head; and metric rule or tape.

(b) Procedure.-The examinee is seated in the dark room facing the dark wall or tangent curtain at 75 cm distance. The spectacle trial frame is adjusted in position and the red lens from the trial lens case is placed in one cell of the trial frame. With the examinee's head in a fixed position, the small lamp is held directly in front of and on a level with the eyes, the light being directly before the dark wall or tangent curtain at 75 cm distance from the eyes. The presence or abscence of diplopia in thos position (primary) is noted. The light is then slowly moved from the central position toward the right for a distance of 50 cm in the horizontal plane. In the same manner the light is moved in the remaining five cardinal directions,

up and to the right, up and to the left, to the left, down and to the left, and down and to the right. The presence or absence of diplopia in any of these positions should be noted. Normally, diplopia should not occur in any meridian within 50 cm of the primary or central position. In the presence of diplopia, notation should be made as to whether it is crossed, homonomous, or vertical, and the distance in cm from the central position that diplopia occurs. Where diplopia is suspected and the examinee has been coached to deny its presence, a prism of 3 or 4 D may be placed, either base up or down, in one cell of the trial frame, and if diplopia is still denied, the statement is obviously untrue.

* (c) Precautions.-The head of the examinee must remain fixed and the movement of the light followed only bt the eyes. No tilting or rotation of the face shall be permitted.

(d) Interpretation of Findings.-Diplopia within 50 cm of the primary position, in any meridian, disqualifies.

1554. Test of Associated Parallel Movements.--

(a) Apparatus.- A pin with a white head 2 mm in diameter.

(b) Procedure.-The examinee stands near a window where good illumination falls on both eyes. The examiner hold the white-headed pin about 33 cm directly in front of the examinee's eyes and directs him to look at it steadily. Nystagmus in the primary position is to be noted at this stage of the test. The examinee is then instructed to hold his head still and watch the pin as it is moved slowly to his right. The pin is not carried beyond the field of binocular fixation, but is held motionless for a moment near the lateral limit of the field. Each eye is inspected to discover any failure in fixing the pin. The lagging or overaction of either eye is noted. The pin is then carried slowly to the extreme left, up and to the left, straight up, up and to the right, to the extreme right, down and to the right, straight down, and down and to the left. The lagging of either eye in any one of these eight cardinal directions is due to underaction of at least one of the extrinsic ocular muscles. The underaction is recorded by stating which eye lags and in which direction the lagging is observed. In the same way any overshooting of either eye is recorded by stating which eye is involved and in which direction. If
* any underaction or overaction is revealed by this test, the final diagnosis shall be made on the tangent curtain by means of the red lens test.

(c) Interpretation of Findings.-The examinee is disqualified if the underaction or overaction of any of the extrinsic ocular muscles results in heterophoria at 6 meters in excess of normal limits, or produces diplopia within 50 cm of the primary position in any meridian as determined by the red lens test.

1555. Inspection of the eyes.-

(a) Procedure.-Whenever possible, the eyes are inspected by bright daylight. Every pathologic condition and congenital anomaly is recorded. The following conditions may be found by this procedure:

Lids: Ptosis, blepharitis, trichiasis, entropion, ectropion, and chalazion.
Tear Sacs: Imperfect drainage.
Lower punctal: Failure of contact with bulbar conjunctiva.
Conjunctivae: Trachoma and old scars.
Corneas: Scars, pannus, and pterygium.
Pupils: Unequal size, irregular shape, and failure to react to light and accommodation.

(b) Interpretation of Findings.-Any pathologic condition which may become worse or interfere with the proper functioning of the eyes under the fatigue and exposure of flying disqualifies.

1556. Accommodation.--

(a) Apparatus.-The Prince rule; a small millimeter rule; a card with several rows of small letters.

(b) Procedure.-Accommodation is measured from the anterior focus of the eye, which is about 11.5 mm in front of the cornea. Using the millimeter rule, a pencil mark is made on each side of the examinee's nose 11.5 mm in front of the right and left cornea, respectively. In measuring the accommodation of the right eye, the flat side of the Prince rule is laid against the right side of the examinee's nose, with the end of the rule at the pencil mark. The rule is held horizontally and extends directly to the front edge up. The card of test letters is held not more than 5 cm in front of the examinee's right eye. His left is screened from sight of the letters by the flat side of the rule. The card of test letters is now carried slowly away from the eye and the examinee is instructed to begin reading the letters aloud as soon as they become legible. The card is halted the instant he begins to read the letters correctly and the point on the rule opposite the card is read off in diopters. This is the measure of accommodation of the right eye. To test the left eye, the rule is changed to the left side of the nose and the above prodedure repeated, using a different line of letters.

(c) Precautions.- The examinee is placed with his back to good light, with the card well illuminated. The card is started from close to the eyes and carried away from them. The letters on the test card are read aloud. The same line of letters is not used for testing both eyes,

(d) Interpretation of Findings.- The following table gives the mean values of accommodation in diopters from 18 to 45 years of age. Accommodation may be regarded as within normal limits provided it is not more than 3 D. below the mean for the examinee's age. The examinee is disqualified if his accommodation falls more than 3 D. below the mean for his age, but before an examinee is disqualified, his accommodation shall be taken on three successive days and an average of the three findings determined. Accommodation may be affected by fatigue, staleness, or other debilitating conditions.

AGE	DIOPTERS	AGE	DIOPTERS	AGE	DIOPTERS	AGE	DIOPTERS
18	11.9	24	10.4	30	8.9	36	7.1
19	11.7	25	10.2	31	8.6	37	6.8
20	11.5	26	9.9	32	8.3	38	6.5
21	11.2	27	9.6	33	8.0	39	6.2
22	10.9	28	9.4	34	7.7	40	5.9
23	10.6	29	9.2	35	7.3	45	3.7

1557. Angle of Convergence.-

(a) Near point of convergence (PcB).- (1) Apparatus.-The Prince rule; a pin with a white head 2 mm in diameter.

(2) Procedure.- The distance to this point is computed from the base line connecting the centers of rotation of the eyes.

The end of the Prince rule is placed, edge up, at the mark on the right side of the nose, 11.5 mm in front of the cornea. The white-headed pin is held 33 cm away in the median line above the edge of the rule and the examinee is instructed to look at it intently. If both eyes are seen to converge upon the pin, it is then carried in the median line, along the edge of the rule toward the root of the nose. The examinee's eyes are carefully watched and the instant one is observed to swing outward the limit of convergence has been reached. The point on the rule opposite the pin is then read in millimeters. This test is repeated until a fairly constant reading is obtained. To this reading 25 mm is added, which will give approximately the distance from the near point of convergence to the base line, PcB.

(3) Precautions.- Both eyes must converge upon the pin at the start of the test. The examinee's observation of the onset of diplopia is not relied upon to determine the near point, although in order to test his veracity he is asked to state when he sees double.

(4) Interpretation of findings.- The near point of convergence, unlike the near point of accommodation, varies little with age. Its measurement is of value only in computing the angle of convergence. Examinees are not qualified or disqualified on this measurement, but on the angle of convergence.

(b) Interpupillary Distance (Pd).--

(1) Apparatus - A small millimeter rule.

(2) Procedure.- The examiner stands with his back to the light, face to face, with the examinee. The rule is held in the examiner's right hand and laid across the examinee's nose in line with his pupils, as close to the two eyes as possible. The examiner closes his right eye and instructs the examinee to fix his eyes on the open left eye. With the eyes in this position, a predetermined mark on the rule is placed in line with the nasal border of the examinee's right pupil. The rule must be held steadily in this position while the examiner opens his right eye and closes his left. The examinee is then instructed to look at the open right eye. The point on the rule in line with the temporal border of the examinee's left pupil is read in millimeters and the exact difference in millimeters between the two points on the rule is the interpupillary distance.

(c) Computing the Angle of Convergence.-(1) Procedure.-The following formula is used for computing the angle of convergence:

$$\text{Angle of convergence} = \frac{\frac{1}{2}\ Pd \times 100}{PcB} + 3$$

(2) Interpretation of Findings.-An angle of convergence of less than 40 degrees is undesirable, but is not disqualifying unless associated with excessive exophoria or diplopia on the tangent curtain, except in the extreme positions.

1558. Central Color Vision.--

* (a) Equipment.-Pseudo-Isochromotic charts prescribed for the Navy.

(b) Procedure.-The examinee is placed with his back to good light (natural light is preferable) in such a manner as to insure that the plates of the chart are illuminated and free of shadow. The plates are exposed to the examinee, who is required to call the numbers or letters indicated in the colored chart. The examinee may be permitted to tilt or alter the position of the charts to improve the light effect. His identification of the numbers should be reasonably prompt.

(c) Interpretation of Findings.-Evidence of color blindness as disclosed by this test shall disqualify. Minor confusion over certain plates will be considered with regard to their importance. In every case where the examinee manifests confusion or inability to pass the test for certain plates, such plates shall be listed in the report of examination with the remark, "Failed", "Confused", or "With Difficulty"- as the case may be.

** 1559. Field of Vision.--

(a) Finger Fixation Test.-The examiner faces the examinee at a distance of 2 feet. He instructs the examinee to close his left eye and to fix his right eye on the examiner's left eye, the examiner's right eye being closed. The examiner then brings his moving fingers in from the periphery midway between them. The examinee is instructed to say when he sees the fingers and how many. He should see them as soon as the examiner, if normal. The fingers are brought in from all cardinal directions. The test is then repeated for the left eye. Any evidence of abnormalities should be given detailed study on the perimeter.

* (b) Interpretation of Findings.-The field of vision for each eye shall be normal as determined by the finger fixation test. Where there is evidence of abnormal contraction of the field of vision in either eye, the examinee will be subjected to perimetric study for form and color. Any contraction of the form field of 15° or more in any meridian shall disqualify.

1560. Refraction (to be done only on original examination or for some special indication).--

(a) Apparatus and drugs.- Electric retinoscope; or plain retinoscope and wall lamp; trial case and trial frame; Snellen test type; and cycloplegic.

(b) Procedure.-The tension of both eyes must be taken by palpation and found normal before instilling a cycloplegic. The fundus of both eyes must also be examined with the opthalmoscope, and if evidences of glaucoma are found a cycloplegic will not be used. One drop of a 4 percent homatropine solution is placed in each eye every 10 minutes until 4 instillation have been made. At the end of 1 hour from the time of the first instillation the examinee is ready for refraction. Retinoscopic examination is conducted in the dark room and the results of the refraction are then verified by having the examinee read the Snellen charts. The minimum correction required to enable the examinee to read 20/20 with each eye is recorded, together with the true correction as determined by retinoscopy.

(c) Interpretation of Findings.-The examinee is disqualified if he requires more than 2 D. total correction in any meridian in order to read 20/20 each eye with the accommodation paralyzed. Of this allowable correction, not more than a total of .5 D. may be due to any form of myopia or astigmatism or any combination thereof.

(d) After treatment.—After the use of a cycloplegic the examinee must wear dark glasses until the effects have disappeared. The instillation into each eye of 1 percent solution of pilocarpine hydrochloride in distilled water will contract the pupil and thus relieve the photophobia.

1561. Ophthalmoscopic Examination.-

(a)Indication and Precautions.-The examination shall be conducted on original examination and when otherwise indicated. The examination must not be made before the refraction is completed. In examining the macular region of the retina, the light should be reduced and the exposure made as brief as possible.

(b) Interpretations of Findings.-Any abnormality disclosed on ophthalmoscopic examination that materially interferes with normal ocular function disqualifies. Other abnormal disclosures indicative of disease, other than those directly affecting the eyes, will be considered with regard to the importance of those conditions.

1562. Ear.—

(a) General.-Both external auditory canals and membrani tympani are examined by means of a speculum and good light. All wax must be removed from the external auditory canal. If external to the bend of the canal, this wax can usually be removed with an ear spud or forceps. If internal to the bend of the canal, the canal should be filled with a bland oil and blocked with cotton. The following day thorough washing of the external canal with a solution of sodium bicarbonate will remove the wax. The external canal is then examined throughout. Any serious permanent blocking of the canal or diseased condition which threatens trouble later on, such as the impairment of hearing, disqualifies. The tympanic membranes are then examined. A perforation or evidence of present inflammation disqualifies. Evidences of serious past inflammation is disqualifying. The presence of a small scar, caused by trouble several years previous which has not recurred and with which there is no deficiency of hearing and no evidence of other inflammation, does not disqualify. Marked retraction of a drum membrane, following chronic ear disease, disqualifies.

(b) Hearing Tests.-Hearing should be normal for each ear. To determine this the whispered voice, the coin-click and watch tests are to be used. A quiet room is essential.

(1) Whispered voice.-The examinee should stand 15 feet from the examiner with the ear being tested turned toward him, the other ear being covered or closed. The examiner, after full expiration, will whisper a number or word and require the examinee to repeat after him, Each ear will be tested in turn. If the examinee is unable to hear at 15 feet, the examiner will approach until he is able to distinguish the words or numbers, the distance being recorded in feet with 15 as the denominator.

(2) Watch test.-The watch test is preferably made with a loud-ticking watch, such as the ordinary Ingersoll, which, while variable, should be heard at about 40 inches. Any watch used should have been previously tried out on at least five normal persons and the distance heard made a matter of record. If the examiner's hearing is normal, he should check the distance at which the watch should be heard against his own hearing, the watch being equidistant from his own ear and that of the examinee. The distance in inches at which the watch is heard by the examinee, eyes closed and opposite ear occluded, is taken as the numerator and the distance the watch should be heard as the denominator. Hearing by this test should be equivalent to 40/40.

(3) Coin-click test.-An assistant closes the ear not under examination. The examiner, 20 feet back of the examinee, then clicks two coins softly together and the examinee is directed to count, aloud, the number of clicks each time. The other ear will then be tested in a similar manner. If unable to hear, the examiner will approach until the examinee does hear, the distance being recorded in feet. Hearing by this test should be equivalent to 20/20.

(c) If the examiner is convinced from the results of the several tests that definite impairment of hearing exists, he will reject the examinee if he be an applicant for aviation training. However, in the case of a qualified flyer, due allowance will be made.

1563. Nasopharynx.-In the examination of the nasopharynx the examiner shall, in general, be guided by the instructions and requirements prescribed for the general service as outlined in paragraphs 1454 and 1455 of this chapter. Any abnormality disclosed on examination indicating an estimated 50 per-cent or more of nasal obstruction, acute or chronic sinusitis, acute or chronic tonsillitis, nasal blockage, mechanical obstruction to drainage of accessory sinuses, occlusion of one or both eustachian tubes, or other abnormalities which may seriously interfere with normal function, shall be cause for rejection.

1564. Equilibrium (Vestibular Tests).--(a) Barany Chair Test.-The nystagmus and falling after turning are tested, when practicable, on original examination and when otherwise indicated.

Where facilities are not available, or circumstances do no permit of this test, then the examination shall be limited to the self-balancing test as outlined in subparagraph (d). Inasmuch as the self-balancing is in effect a modified Romberg test, all examinees shall undergo that test as a regular part of their examination.

(b) Nystagmus.- Examinee's head is inclined 30 degrees forward, so that the tragus of the ear is on a horizontal line with the external canthus of the eye. The examinee is then asked to fix his eyes on a distant point and the chair turned slowly from side to side in order to note whether or not spontaneous nystagmus is present. Then turn examinee to the right, eyes closed, 10 times in exactly 20 seconds. The instant the chair is stopped, click the stop watch; examinee opens his eyes and looks straight ahead at some distant point. There should occur a horizontal nystagmus to the left of 26 seconds' duration. Examinee then closes his eyes and is turned to the left; there should occur a horizontal nystagmus to the right of 26 seconds' duration. A variation of 10 seconds above or 12 seconds below is allowable.

(c) Falling.- Examinee's head is inclined 90 degrees forward, resting his forehead on his upper fist, his fists being placed one above the other on his knees, which are brought close together. Turn to the right, five times in ten seconds. On stopping, examinee raises his head and should fall to the right. This tests the vertical semicircular canals. Turn to the left, head forward 90 degrees; on stopping, the examinee raises his head and should fall to the left.

(d) Self-balancing test.- The applicant stands erect, without shoes, with heels and toes touching. He then flexes one knee to a right angle, being careful not to support it against the other leg, closes his eyes, and endeavors to maintain this position for 15 seconds. The test is then repeated on the other foot. The findings are recorded as "steady", "fairly steady", "unsteady", or "failed". The applicant should be instructed that this is the equilibrium test. There is no objection to his assisting his balance by moving and bending back and forth.

(e) Interpretation of Findings.- Inability to pass the test for equilibrium satisfactorily shall be cause for rejection.

DISQUALIFYING FACTORS IN THE AVIATION PHYSICAL EXAMINATION FOR FLYING

1. A MEDICAL HISTORY OF THE FOLLOWING DISQUALIFIES:

   (a) Syphilis
   (b) Repeated attacks of hay fever or asthma
   (c) Recent attacks of malaria
   (d) Paroxysmal tachycardia
   (e) The presence of any organic heart disease
   (f) Recurrent attacks of any of the rheumatic group
   (g) Renal calculus (recent)
   (h) Encephalitis lethargica or any illness accompanied by diplopia and lethargy.

2. HEIGHT and WEIGHT:

   Minimum height for officers is 66 inches.
   Minimum height for enlisted men and cadets is 64 inches.
   Maximum height for all personnel is 76 inches.

   Minimum weight for officers is 132 lbs.
   Minimum weight for enlisted men and cadets is 124 lbs.
   Maximum weight for all personnel is 200 lbs.

3. CHEST:

   Expansion of 3 inches is desired. A variation of $\frac{1}{2}$ inch is allowable if the individual is otherwise acceptable. Any condition that serves to impair respiratory function may be cause for rejection.

4. FEET:

   Flat feet causing symptoms are disqualifying.

5. BLOOD PRESSURE:

   If examinee is a candidate for flight training the systolic pressure s hall not persistently exceed 135 mm., nor the diastolic exceed 90 mm. In case of qualified pilots over 25 years of age, the systolic pressure shall not persistently exceed 150 mm. nor shall the diastolic be above 95 mm. If the pilot is under 25 years of age, the systolic shall not exceed 140 mm. A systolic pressure of less than 105 mm. disqualifies.

6. CIRCULATORY EFFICIENCY:

An index below 8 will be regarded as unsatisfactory.

7. URINALYSIS:

Urine should be free from albumin and sugar or any abnormal microscopical findings.

8. VISUAL ACUITY

On original examination 20/20 for each eye is required. In case of qualified pilots not less than 15/20 for each eye unaided by glasses may be permitted.

9. DEPTH PERCEPTION:

An average of 30 mm or less for 5 readings is required.

10. EYE MUSCLE BALANCE:

Esophoria of more than 4 diopters, if associated with less than 4 diopters of prism divergence, or if associated with diplopia in the lateral positions on the tangent curtain; or associated with the amount of accommodation near the lower limits, or if associated with hyperopia near the disqualifying limits. Esophoria of more than 10 diopters disqualifies even if unassociated with any other visual defect. Exophoria of more than 5 diopters disqualifies. Hyperopia of more than 1 diopter disqualifies.

PRISM DIVERGENCE:

A prism divergence of more than 15 diopters or less than 2 diopters disqualifies.

Where there exists an Esophoria at 6 meters, the prism divergence shall equal or exceed the esophoria in prism diopters.

11. ASSOCIATED PARALLEL MOVEMENTS:

The examinee is disqualified if the underaction or overaction of any of the extrinsic ocular muscles results in heterophoria at 6 meters in excess of normal limits, or produces diplopia within 50 cm of the primary position in any meridian as determined by the red lens test.

12. NYSTAGMUS:

Nystagmus disqualifies if it be demonstrated, except in extreme positions.

13. INSPECTION OF THE EYE:

Any pathologic condition which may become worse or interfere with the proper functioning of the eyes under fatigue and exposure of flying disqualifies.

14. ACCOMODATION:

The examinee is disqualified if his accommodation falls more than 3 diopters below the mean for his age, but this must be an average taken on 3 successive days.

15. ANGLE OF CONVERGENCE:

An angle of convergence of less than 40 degrees is undesirable, but is not disqualifying unless associated with excessive exophoria or diplopia on the tangent curtain, except in extreme positions.

16. COLOR VISION:

Evidence of color blindness as disclosed by this test shall disqualify. In every case where the examinee manifests confusion or inability to pass the test for a certain plate, such plates shall be listed in the report with the remark, "Failed", "Confused", or "With Difficulty" as the case may be.

17. REFRACTION:

The examinee is disqualified if he requires more than 2 diopters total correction in any meridian in order to read 20/20 each eye with accommodation paralyzed. Of this allowable correction, not more than a total of 0.5 diopter may be due to any form of myopia or astigmatism or any combination thereof.

18. EARS:

Hearing should be normal for each ear.

Any serious permanent blocking of the canal or diseased condition which threatens trouble later on, such as to impair hearing, disqualifies. A perforation or evidence of serious past inflammation disqualifies. Marked retraction of a drum membrane following chronic ear disease disqualifies.

After several tests if definite impairment of hearing is shown, the examinee is disqualified if an applicant for training. However, if a qualified pilot, due allowance will be made.

19. NASOPHARYNX:

Any abnormality disclosed on examination indicating an estimated 50% or more nasal obstruction, acute or chronic sinusitis, acute or chr nic tonsillitis, nasal blockage, mechnical obstruction to drainage of accessory sinuses, occlusions of one or both eustachian tubes, perforated nasal septum, or other abnormalities which may seriously interfere with normal function, shall be cause for rejection.

20. EQUILIBRIUM:

A variation of 10 seconds above or 12 seconds below the standard of 26 seconds of nystagmus is allowed. The examinee should fall in direction turned on the falling test.

APPENDIX D, MANUAL OF THE MEDICAL DEPARTMENT

BUREAU CIRCULAR LETTER R

July 1, 1940

Subject: Physical Requirements for Aviation Personnel.

SERVICE GROUPS, NAVAL AVIATORS

(a) For the purpose of assignment to unrestricted flight duties, pilots of naval aircraft (heavier-than-air), are divided into three service groups. The policies relating to these service groups, and the physical requirements prescribed for each, as approved by the Bureau of Navigation are:

1. Service Group 1:

(aa) - Definition of employment: Pilots with less than 20 years naval service. Unrestricted flying.

(bb) - Physical requirements: The physical requirements shall be the same as now set forth in section XXIII, chapter II, of the Manual of the Medical Department, U.S. Navy.

2. Service Group 2:

(aa) - Definition of employment: Pilots with from 20 to 30 years naval service. Will not be assigned to VF squadrons or as active student instructors unless their special fitness therefor has been determined.

(bb) - Physical requirements: (For unrestricted flying within the service group.) The physical requirements shall be the same as prescribed for service group 1, with the following exceptions: (1) Visual acuity shall be not less than 10/20 for each eye unaided by glasses, provided that where visual acuity is less than 13/20 for either eye, it shall be corrected by lenses to 20/20 and the correction shall be worn while flying. (2) Depth perception shall not exceed 35 mm. with glasses. (3) Accommodation below the requirements for age is permissible, provided that accommodation for each eye shall not be less than 3 diopters without correction. (4) Moderate defects of hearing may be permitted, but shall not exceed the minimum of 7/15 whispered voice, binaural.

3. Service Group 3:

(aa) - Definition of employment: Pilots with 30 or more years naval service who normally will be expected to perform flight in executive or broad command status. Solo flying will be performed in such basic types of naval aircraft as may be prescribed by the Chief of the Bureau of Aeronautics as deemed commensurate with their physical and service qualifications.

(bb) - Physical requirements: (For unrestricted flying within the service group.) The physical requirements shall be the same as prescribed for service group 1, with the following exceptions: (1) Visual acuity shall be not less than 8/20 for each eye, unaided by glasses, provided that where visual acuity is less than 13/20 for either eye, it shall be corrected by lenses to 20/20 and the correction shall be worn while flying. (2) Depth perception shall not exceed 35 mm. with glasses. (3) Accommodation below the requirements for age is permissible, provided that accommodation for each eye shall not be less than 3 diopters with the aid of glasses, which correction shall be worn while flying. (4) Heterophoria: Muscle balance of the eyes shall be within the standards prescribed for service group 1, provided however, that where the examinee has defective vision which is correctible by glasses within the limits prescribed in subparagraph (a)3(bb)(1) above, such correction may be worn while undergoing the test for heterophoria and shall be worn while flying. (5) The angle of convergence test may be omitted, unless specifically indicated with relation to other associated findings near the disqualifying limits. (6) Hearing shall be the same as prescribed for service group 2. (7) Blood pressure: The diastolic blood pressure shall not exceed 95 mm. Hg. The systolic blood pressure shall normally not exceed 155 mm. Hg.

(b) Should any pilot fail to meet the physical requirements prescribed for unrestricted flying in one of the foregoing groups, such failure shall be set forth in the report of physical examination for flying (NMSAv-Form 1), with the inclusion for consideration of one of the following recommendations:

1. Be permitted to continue unrestricted flight status of his service group subject to waiver by the Bureau of Navigation.
2. Be restricted to flight duties next higher service group, i.e., from 1 to 2, or 2 to 3.
3. Be restricted to flight duties of a lessened tempo commensurate with present (temporary) physical condition. (Limited to pilots recuperating from injuries or hospitalization).
4. Restricted to flight duties requiring one unrestricted pilot of service group 1 or 2 in the plane.
5. Flight status ceases.

(c) The reports of physical examination for flying (NMSAv-Form 1) shall be prepared and forwarded to the Bureau of Medicine and Surgery in accordance with existing instructions.

NON-FLYING PERSONNEL

(d) Physical requirements for non-flying personnel groups 8 to 10 inclusive, (paragraph 1536 (a), Manual of the Medical Department, U.S. Navy) are as follows:

1. Naval Aviation Observer: For naval aviation observer, candidates shall normally be required to meet the standard physical requirements prescribed for the general service with the following additional requirements for flying, namely, accommodation of the eyes, circulatory efficiency, nasopharynx, equilibrium and the neuro-psychiatric examination. However, for assignment to flying duty as tactical reconnaissance observer or aircraft gunnery observer, personnel shall in addition to the physical requirements specified for naval observer, have vision of not less than 20/20 in each eye, unaided by glasses, and shall have normal color vision as determined by the Stilling's test. Reports of examination shall be made on NMSAv-Form 1, as provided in paragraph 1564 of the Manual of the Medical Department, U.S. Navy.

2. Naval Flight Surgeon: Naval flight surgeons ordered to duty involving flying (not in control of aircraft), shall meet the standard physical requirements prescribed for naval aviation observer (general), subparagraph (c) (1) above. Report of examination shall be made on NMSAv-Form 1, as provided for naval aviators.

3. Student Naval Flight Surgeon: The physical requirements prescribed for student naval flight surgeons are the same as those prescribed for qualified naval flight surgeons, provided that for the purpose of flight indoctrinal training, in order to be physically qualified to solo elementary type aircraft, vision shall be not less than 15/20 each eye unaided by glasses, and depth perception shall not exceed 25 mm. Failure to meet these special requirements of the eyes shall serve to disqualify for solo flying only, but shall not disqualify for other indoctrinal training involving flying, leading to the designation of flight surgeon. The report of examination shall be made on NMSAv-Form 1, as provided in paragraph 1546, Manual of the Medical Department, U.S. Navy.

(Note: See BuNav Cir.ltr.No.37-42 on page 65 for additional requirements.)

4. Anti-aircraft and Aircraft Machine Gunners: Anti-aircraft and aircraft machine gunners shall meet the general physical requirements provided for naval observer (general), subparagraph (c)(1) above, with the following additional requirements:

(aa) Vision shall be not less than 20/20 for each eye unaided by glasses.

(bb) Depth perception shall be not more than 25 mm. as now prescribed for naval aviators.

(cc) Color vision shall be normal as determined by Stilling's test.

(ee) Normally, the eyes will not be refracted. However, where evidence of myopia is suspected, the eyes will be refracted and evidence of myopia will disqualify.

(ff) Personnel designated for assignment to duty as anti-aircraft and aircraft machine gunners shall report for physical examination by a flight surgeon preliminary to such duty. Local commanding officers shall require such personnel under their command to be physically examined in accordance with these standards, once each year. An entry shall be made in the special duty abstract of the individual's health record indicating the result of the examination, and the responsible commanding officer officially notified as to the individual's physical qualifications for such duty. Report of this physical examination will not be made to the Bureau of Medicine and Surgery, the entry in the health record will serve for this purpose.

5. Other Non-flying Personnel, Group 10 (paragraph 1539 (a), Manual of the Medical Department, U.S. Navy: Other non-flying personnel ordered to duty involving flying, for which specific requirements have not been prescribed, shall, preliminary to engaging in such flying duties, be examined physically to determine their physical fitness to engage in aerial flights. The examination shall relate primarily to the circulatory system, equilibrium, neuropsychiatric stability, patency of the eustachian tubes, with such additional consideration as the individual's specific flying duties may indicate. The result of these examinations will be entered in the special duty abstract of the individual's health record and their respective commanding officers notified as to their physical qualifications. No report of these examinations will be submitted to the Bureau of Medicine and Surgery.

NAVY DEPARTMENT
BUREAU OF NAVIGATION
Washington, D. C.

Nav-63-OWC
P2-5(301)

March 10, 1942

BUREAU OF NAVIGATION CIRCULAR LETTER NO. 37-42.

From: The Chief of the Bureau of Navigation.
To : All Ships and Stations.

Subject: Aircraft Machine Gunner - Additional requirements for.

Reference: (a) BuM&S Cir.Ltr. R, Appendix D Manual of Medical Department, Par. #4, dated July 1, 1940.

1. Reference (a) prescribes the physical requirements for Aircraft Machine Gunners. Equipment now under design, and the nature of the duties required of Aircraft Machine Gunners, necessitate a modification of the military requirements (physical) prescribed for this personnel.

2. Effective immediately, the below listed requirements for Aircraft Machine Gunners are hereby prescribed, and are in addition to the requirements prescribed by reference (a):

(a) Maximum weight shall be 160 pounds.

(b) Maximum height shall be 5 feet 10 inches.

(c) Must have clear diction for normal spoken voice.

(d) Must have no defect of hearing that is sufficient to interfere with radio perception.

3. In addition to the above, only volunteers shall be considered acceptable for duty as Aircraft Machine Gunners.

4. All Aviation Machinist's Mates, Aviation Radiomen and Aviation Ordnancemen now in the service, and men in training for these ratings shall be immediately examined to determine their physical fitness for duty as Aircraft Machine Gunners, in accordance with the requirements of reference (a), and of paragraph 2 of this letter.

5. Commanding Officers shall have appropriate entries made in the service records of men found physically qualified and who are recommended as fitted and adapted for Aircraft Machine Gunner training.

L. E. Denfeld
Assistant Chief of Bureau

SECTION IV

DENTAL STANDARDS

PAGES 66 to 69 inclusive

DENTAL STANDARDS

(Paragraph 1458-1462, Manual of the Medical Department)

The teeth and the mouth shall be examined by a dental surgeon if one be available.

To be accepted for enlistment and applicant must have a minimum of 20 vital servicable permanent teeth including 4 opposed molars, 2 of which are directly opposed on each side of the dental arch, and 4 directly opposed incisors, 2 of which are on either side of the median line.

(NOTE) For the duration (except class V-7) applicants may be accepted for enlistment providing they have 18 sound vital teeth with at least 2 molars in functional occlusion and not more than 4 incisors missing which have been satisfactorily replaced.

The explanation of standards in paragraph 1461 shall apply in interpreting the above requirements.

For a commission the teeth in the mouth shall be examined by an officer of the Navy Dental Corps who shall state in the record whether or not the candidate is dentally qualified for appointment.

The candidate must meet the standards as required for enlistment and in addition must present a higher standard as to the formation and condition of the teeth, occlusion, the condition of the soft tissues and such restorations and replacements as may be present.

A candidate for appointment to the Naval Academy must meet the dental requirements for commission and in addition there must be fewer restorations, the deviation from normal occlusion, if any, must be minor, and good functional occlusion must be demonstrable as well as absence of interference with speech.

At time of acceptance of the candidate he must have received all required dental treatment including permanent restorations of carious teeth and the removal of deposits.

EXPLANATION OF STANDARDS

A vital tooth is a tooth containing a vital dental pulp.

A servicable tooth is one which is fully effective functionally; is free from advanced disease; is adequately supported by normal tissues, and does not have a faulty restoration, or faulty crown or bridge attachment.

A permanent tooth is a natural tooth of the normal second dentition. Deciduous and supernumerary teeth shall not be included.

An opposed tooth is one that comes into functional contact with one or more teeth of an opposite arch.

A vital tooth which is carious to a limited extent and which is otherwise servicable, and which can be restored satisfactorily without endangering the pulp, may be counted as a servicable tooth. Appointees, as midshipmen, must have had all carious teeth restored or extracted.

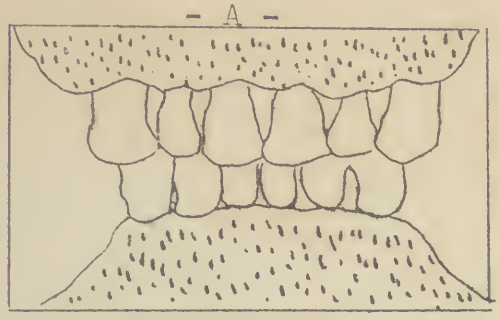
A bicuspid may not be counted as a molar nor may a cuspid be counted as an incisor.

An abutment tooth (a natural tooth to which a bridge is attached) may be counted as a servicable tooth only when the pulp is vital, the tooth is sound, and the bridge attachment is well designed and is in good condition.

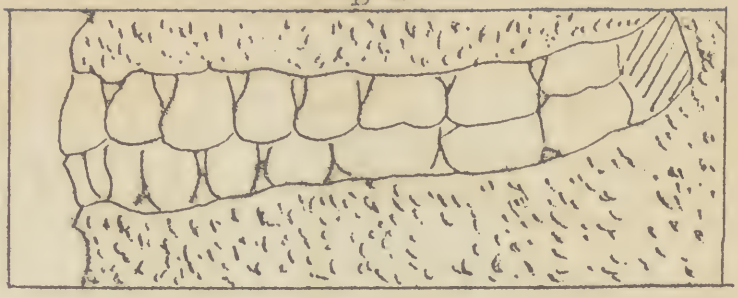
CAUSES FOR REJECTION

1. The loss of teeth in excess of the standards noted in paragraph 1458, Med.Dept.Manual.
2. Marked protrusions or retrusion of the mandible.
3. Marked deformity of the maxillae or mandible.
4. Marked malocclusion.
5. Dento-facial deformity.
6. Lack of servicable occlusion.
7. Overbite with impingement of the lower teeth upon the upper gingiva.
8. Numerous wide spaces that are edentulous (without natural teeth.)
9. Extensive or numerous unsatisfactory restorations by fillings, inlays, crowns, bridges or dentures.
10. Teeth generally unservicable because of insufficient size or poor formation.
11. Teeth generally involved with caries.
12. Teeth generally unsound or unsightly because of faulty calcification.
13. Pulpless teeth with defective or no pulp canal fillings.
14. Apical or extensive pericemental areas of infection.
15. Teeth carious beyond restoration.
16. Large deposits of salivary calculus.
17. Advanced or extensive pyorrhea alveolaris.

- A -

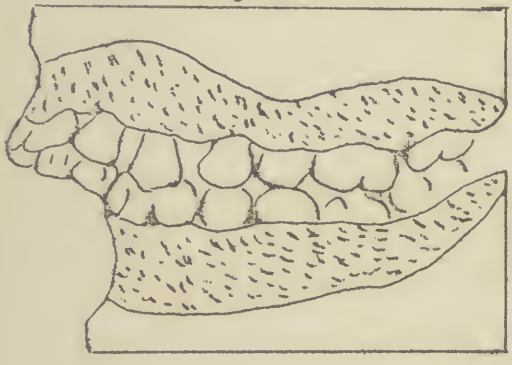


- B -

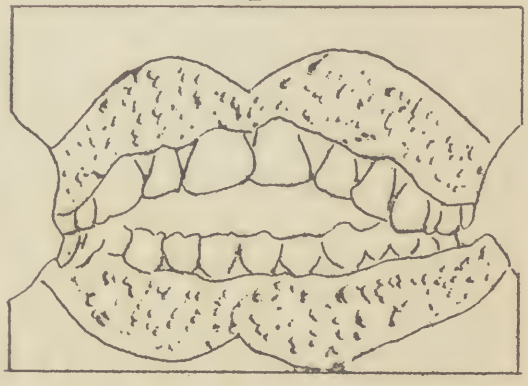


The above diagram exhibits normal occlusion. Figure A (front view) shows cuspid and incisor teeth, while figure B is a side view of a molar, bicuspid, cuspid and incisor teeth in their proper relationship.

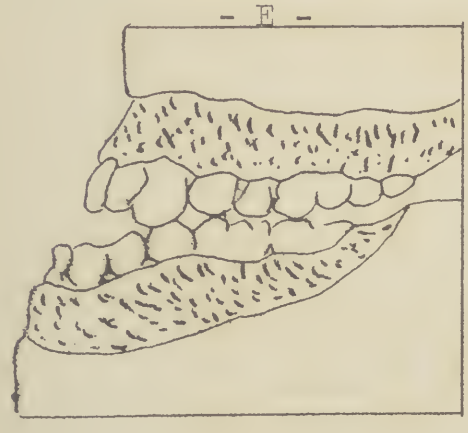
- C -



- D -



- E -



Diagrams C, D, and E, exhibit several forms of malocclusion, all of which should cause the rejection of candidate presenting such a condition.

- G -

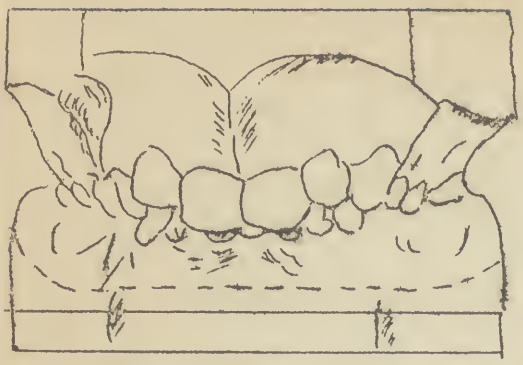
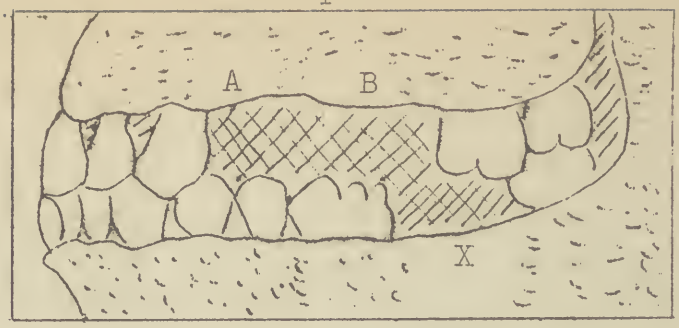


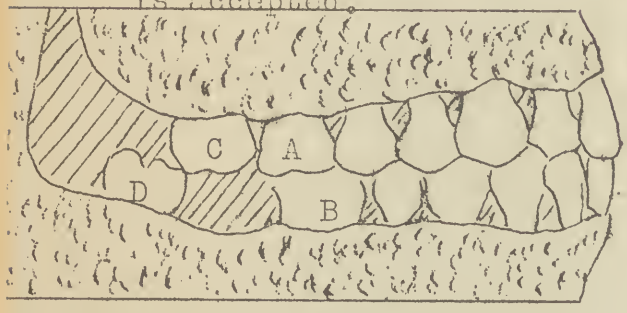
Diagram G presents closed bite and does NOT meet Navy Standards.

- F -



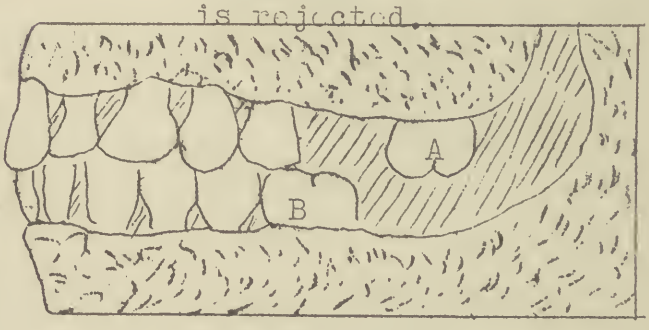
In diagram F the edentulous space resulting from the loss of 1 molar tooth as indicated by letter X is not sufficient cause for rejection, while the loss of several teeth resulting in a WIDE EDENTULOUS SPACE as indicated by letters A & B is sufficient cause for rejection.

CANDIDATE "A" is accepted.



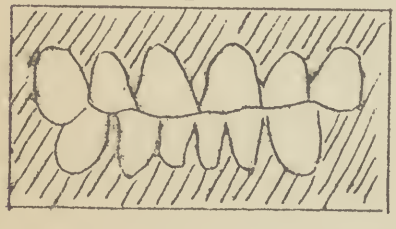
In above diagram, molars A and B are opposed, C and D are not opposed.

CANDIDATE "B" is rejected.



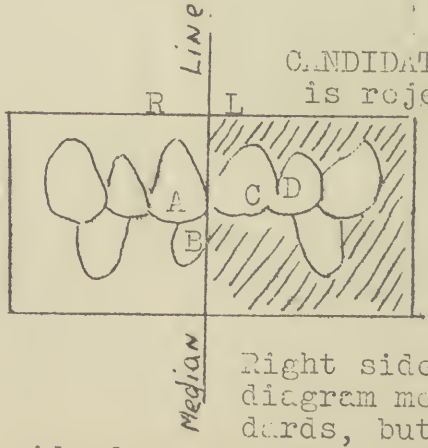
In above diagram, molars A and B are not opposed.

CANDIDATE "C" is accepted.



Above diagram presents a normal occlusion (bite) and number of incisor teeth.

CANDIDATE "D" is rejected.



Right side of above diagram meets standards, but left side does not have necessary number of opposed teeth.

SECTION V

AVIATION PHYSIOLOGY

PAGES 70 to 95 inclusive

AVIATION PHYSIOLOGY

FOR AVIATION MEDICINE TECHNICIANS

Aviation medicine technicians may be required, and at present are being required to assist the Flight Surgeon in oxygen indoctrination work. This work may take place at a station where a low pressure chamber is available or with an actual combat squadron in the field or aboard ship. It is part of the Flight Surgeon's duty to assist the squadron oxygen officer in familiarizing the pilots and men in the use of extra oxygen and oxygen supply equipment. The more the technician knows about this work the more value he will be to the Flight Surgeon.

The Battle of B ritain, the German blitz both to the East and to the West, and the success of the Japanese in Malaya and the East Indies have established for all time in the minds of civilians the paramount importance of the Air Arm. Large numbers of magazine articles bearing upon the need of extra oxygen at high altitudes have concurrently made their appearance. To Navy personnel connected with aviation, this is tried and accepted knowledge; indeed, a whole section of the Medical Department centers around conditions associated with flying, and when this involves altitudes in excess of 10,000 feet, the use of oxygen and the combatting of cold temperatures become major considerations.

The history surrounding balloon ascents reveals dramatically the experiences and sensations which these adventurers met and their descriptions are not surpassed even now. As early as 1862, two Englishmen, Glaisher and Coxwell, ascended to 29,000 feet. Glaisher noted strange symptoms: a loss of accurate vision and hearing, paralysis of the arms and legs, and eventually became unconscious. His companion also found his arms paralysed, but retained the presence of mind to seize the valve rope in his teeth and start the balloon downwards.

Glaisher's published account of this experience came into the hands of the famous French physiologist, Paul Bert, who has come to be regarded as the father of Aviation Medicine. He experimented in a low pressure tank of his own making and wrote a comprehensive volume entitled, "La Pression Barometrique." In 1875, three of those working with him, Tissandier, Croce, and Sivel made a disastrous balloon ascent to 28,820 feet. The description by Tissandier gives such complete picture of the effects of oxygen want that it is quoted in part: "I now come to the fateful moments when we were overcome by the terrific action of reduced pressure. At 22,900 feet------tormor

had seized me. I wrote nevertheless-----though I have no clear recollection of writing. We are rising. Croce is panting. Sivel shuts his eyes. Croce also shuts his eyes-----. At 24,000 feet the condition of torpor that overcomes one is extraordinary. Body and mind become feebler----There is no suffering. On the contrary, one feels an inward joy. There is no thought of the dangerous position; one rises and is glad to be rising. I soon felt myself so weak that I could not even turn my head to look at my companions----I wished to call out that we were now at 26,000 feet, but my tongue was paralysed. All at once, I shut my eyes and fell down powerless, and lost all further memory." The balloon ascended to 29,000 feet and then descended of its own accord. At around 15,000 feet, he regained consciousness and, even with his companions slumped at his feet, he tossed over the sandbags with a reckless abandon and the balloon again ascended until unconsciousness reoccurred, and later descended. Tissandier recovered, and the others were dead. In addition to this excellent description of the symptoms of oxygen lack, the account serves in an excellent way to emphasize the loss of judgement, for no one in his right mind would deliberately undertake a second ascent with two unconscious companions at his feet.

If we are to know clearly why such symptoms and behavior occur, then it is obvious we must understand--

1. THE AIR WE BREATHE AND ITS CONTENTS.
2. THE MECHANISM OF BREATHING.
3. THE RESULTS OF INSUFFICIENT OXYGEN.

The strategy of military aviation calls for the highest ceilings possible and, since engineers have produced planes which will fly in the stratosphere, it is up to the Medical Department to provide ways and means of enabling pilots to perform efficiently and safely at these heights. Accordingly, two other problems must be included and these are (1) COLD and (2) AEROEMBOLISM (BENDS). The first of these can be covered while considering Air, and the second will be dealt with separately.

AIR

The purpose of breathing is roughly to get the oxygen of the air outside of us to the various organs inside of our bodies. To do that, it has first to get into our LUNGS, and then from the lungs the BLOOD carries it to all the organs and tissues inside. In the cells of these organs it meets the foodstuffs also brought there by the blood. COMBUSTION occurs and, as in all forms of combustion, HEAT is given off and CARBON DIOXIDE formed. The heat keeps our bodies warm and the carbon dioxide has to be removed from our bodies; so it goes into the blood, which, in turn, delivers it to the lungs, from which it is pumped out when we exhale. Once the carbon dioxide is in the open

air, it is sooner or later picked up by the chlorophyll (the green coloring matter of the leaves, grass, etc.) and reconverted into oxygen. Thus, animals and plants produce the element vital to the life of the other, and maintain an exact balance between the oxygen and carbon dioxide in the air.

Therefore, in our study of air, it is necessary to study it; first, outside ATMOSPHERIC AIR, second, in the lungs ALVEOLAR AIR; and third, in the BLOOD that carries it.

1st Outside	2nd in the Lungs	3rd in the	4th
Atmospheric Air	Alveolar Air	Blood	Tissues

ATMOSPHERIC AIR

COMPOSITION BY VOLUME.

Oxygen (O_2)	= 20.93%
Carbon dioxide (CO_2)	= .03%
Nitrogen (N_2)	= 79.04%

Rare gases, such as Neon, Helium, Crypton, etc. are found in such very small quantities that they can be neglected.

These proportions are so constant that such scientific instruments as gas analyzers can be checked for accuracy anywhere in the world by simply taking a sample of air and noting if they yield these percentages. Furthermore, whether samples be taken at sea level, 50,000, or 100,000 feet, the same percentages exist. It is estimated that one has to go 60 miles into the air before the oxygen drops off to 0% and 100 miles before the nitrogen ceases to exist.

If, therefore, the composition of air is the same at these high levels, why does not life exist there? Why do planes climb less rapidly as they gain very high altitudes? Why does the average motor fail? Why does one's brain cease to function? The answer is the thinness and diminished density of the air, which means it has less weight and so exerts less PRESSURE.

PRESSURE. A column of air one inch square and extending from sea level to heaven weighs fifteen pounds, so air exerts a pressure of fifteen pounds per square inch of surface at sea level. At 18,000 feet, one half of the bulk of air will be below you and one half still pressing down upon you, so the pressure per square inch will be seven and a half pounds, and the higher you go, the less weight of gas will be above you, and, proportionally, the less pressure it will exert.

Now, our bodies were developed for essentially sea level conditions, and require this full pressure of fifteen pounds per square inch to drive the oxygen of the air into our blood in adequate concentrations to maintain our usual health. At higher altitudes, there simply is not a sufficient head of pressure to do this.

The Effects of Low Oxygen Pressure are noted at the following levels:

4,000 - 5,00 feet = Onset of symptoms.
10,000 - 15,000 feet = Symptoms moderately severe.
15,000 - 18,000 feet = Symptoms severe.
18,000 - 24,000 feet = Unconsciousness.
24,000 - 30,000 feet = Death.

An altitude of 22,000 feet is considered the critical level, at which the chances are even between a man temporarily adjusting or collapsing.

Another way of measuring the weight or pressure of air is the barometer. In this instrument, a long tube closed at one end is completely filled with mercury and a finger placed over the open end. This end is then placed below the surface of a pool of mercury in a dish or vessel and the finger removed. The mercury in the tube will then fall to a point 30 inches above the surface of that in the dish. In other words, the weight of the air (15 lbs. per sq. in.) is balancing this column of mercury. In scientific work and in aviation the French Metric System is used, and in this, 30 inches measures 760 millimeters. This figure should be remembered and will frequently be referred to. For convenience in understanding equivalents, the following table should be studied and familiarized.

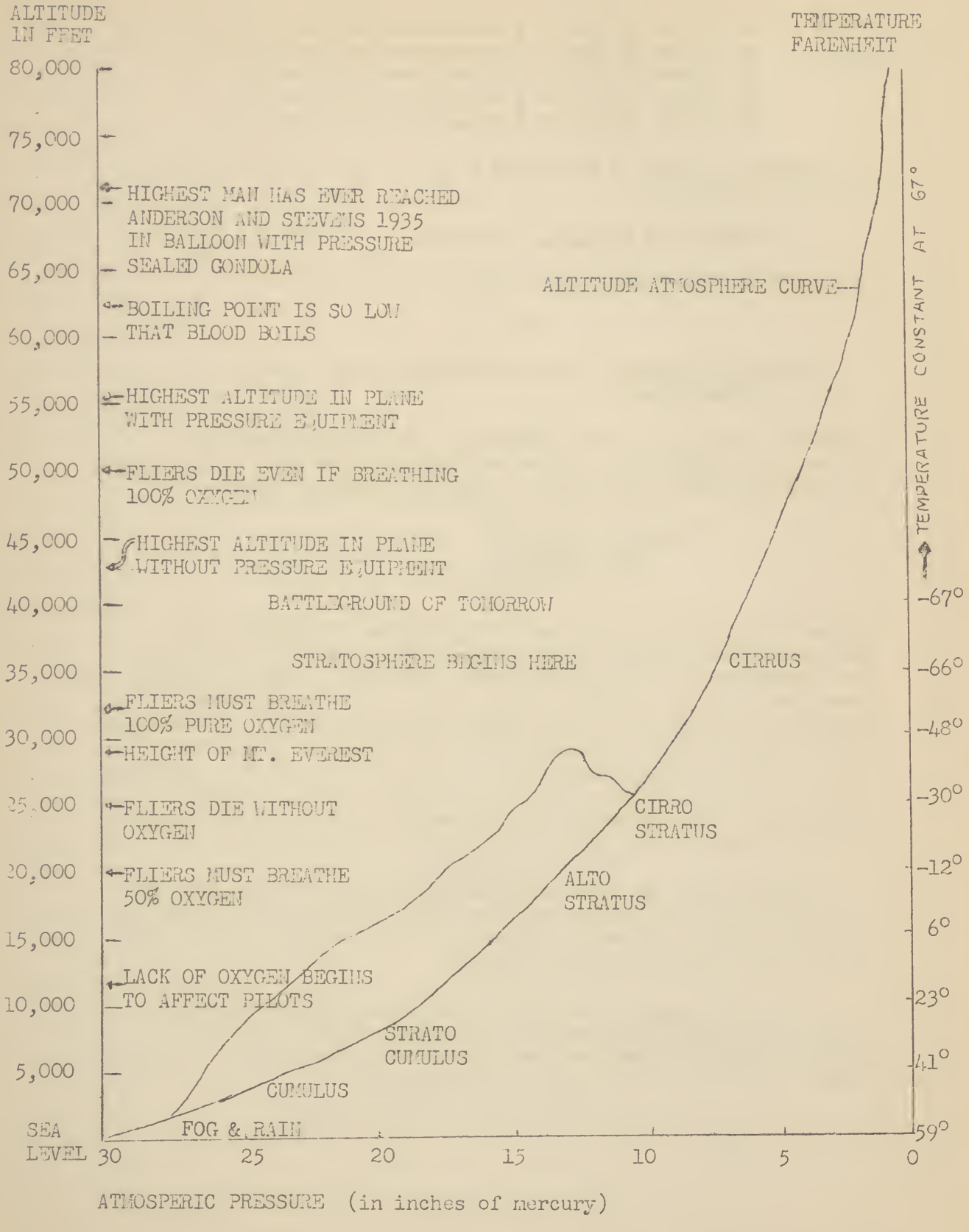
Altitude	Weight in Atmospheres	Volume	Pounds per square inch	Height of Mercury Column Inches	Millimeters
Sea level	1	1	15	30	760
18,000 ft.	½	2	7½	15	380
28,000 ft.	1/3	3	5	10	254
34,000 ft.	1/4	4	3 3/4	7½	190
42,000 ft.	1/6	6	2 1/2	5	127

THE PRESENT INDOCTRINATIONAL TRAINING in the low pressure chamber at Pensacola calls for remaining at 18,000 feet for 13 minutes without extra oxygen and, then, after putting on masks, ascending to 28,000 feet for 3 minutes.

CLASSIFICATION RUNS for those selecting carrier duty involving high altitude intercepter action, consist in remaining at 35,000 feet for one hour using oxygen, as a test for "Bends"; afterwards, descending to 18,500 feet and remaining there for one half hour without masks to test one's capacity for withstanding low pressures over longer periods.

Law Relating to the Effect of Pressure Upon Volume.

Note from the table how volume doubles when the pressure is one-half, triples when pressure is one-third of an atmosphere, and you will recall one of the fundamental Gas Laws known as Boyle's Law which says: The volume of a gas is inversely proportional to the pressure exerted upon it.


ALTITUDE IN FEET
TEMPERATURE FARENHEIT
80,000
75,000
70,000
65,000
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
SEA LEVEL
HIGHEST MAN HAS EVER REACHED ANDERSON AND STEVENS 1935 IN BALLOON WITH PRESSURE SEALED GONDOLA
BOILING POINT IS SO LOW THAT BLOOD BOILS
HIGHEST ALTITUDE IN PLANE WITH PRESSURE EQUIPMENT
FLIERS DIE EVEN IF BREATHING 100% OXYGEN
HIGHEST ALTITUDE IN PLANE WITHOUT PRESSURE EQUIPMENT
BATTLEGROUND OF TOMORROW
STRATOSPHERE BEGINS HERE
FLIERS MUST BREATHE 100% PURE OXYGEN
HEIGHT OF MT. EVEREST
FLIERS DIE WITHOUT OXYGEN
FLIERS MUST BREATHE 50% OXYGEN
LACK OF OXYGEN BEGINS TO AFFECT PILOTS
ALTITUDE ATMOSPHERE CURVE
CIRRUS
CIRRO STRATUS
ALTO STRATUS
STRATO CUMULUS
CUMULUS
FOG & RAIN
TEMPERATURE CONSTANT AT 67°
-67°
-66°
-48°
-30°
-12°
6°
23°
41°
59°
30
25
20
15
10
5
0
ATMOSPERIC PRESSURE (in inches of mercury)

Thus, 12 liters of gas at 1 atmosphere pressure will be
6 liters of gas at 2 atmospheres of pressure or
4 liters of gas at 3 atmospheres of pressure or
24 liters of gas at $\frac{1}{2}$ atmosphere pressure or
48 liters of gas at $\frac{1}{4}$ atmosphere pressure, etc.

The product of each of these (12 x 1, 6 x 2, $\frac{1}{4}$ x 48) all equals 12, so we can say -

Pressure x Volume = a Constant

The formula representing this last is $P \times V = P' \times V'$

or

Original Pressure x Original Volume = New Pressure x New Volume.

Example: Suppose we have 2 liters of gas in our intestines at sea level (760 mms.) and we want to find how much there will be at 28,000 feet (254 mms.). Using the above formula -

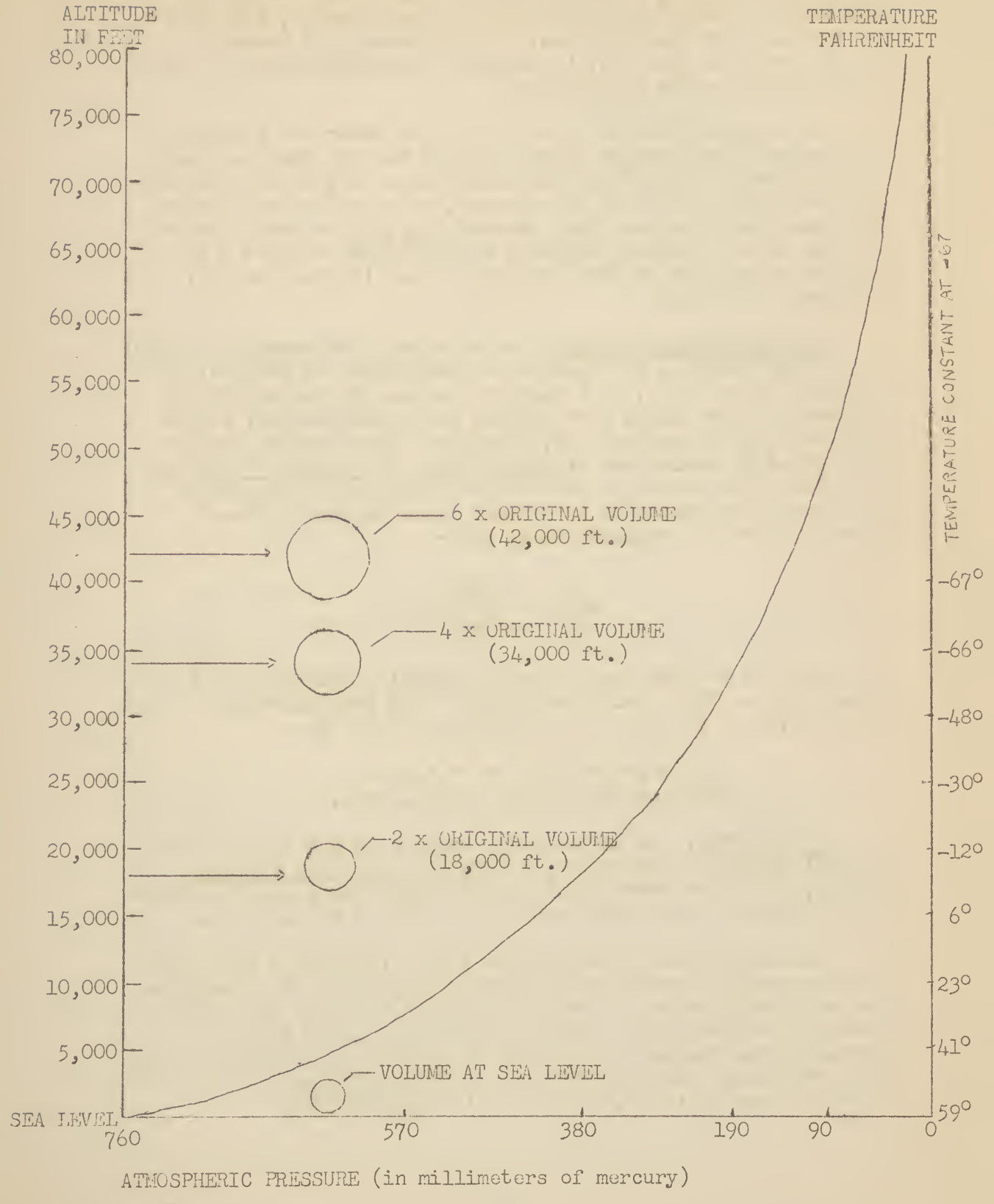
$$760 \times 2 = 254 \times V'$$
$$1520 = 254V'$$
$$V' = 6 \text{ liters.}$$

Behind this simple law lie all the problems associated with abdominal distension in high altitude flying and, accordingly, the importance of dietary regulation and the avoidance of such gas-forming foods as beans, beer, soda, frothy milkshakes, pastries, cabbage, etc.; also the need for evacuating the bowels before flying, thus getting rid of large numbers of bacteria, which, working upon foodstuffs in the intestines, would produce gas. The expansion of gas in the abdomen exerts a pressure upward upon the diaphragm and compresses the bases of the lungs, so making unavailable that much-needed breathing space.

Behind this Law also lies the explanation of ear popping and dental pain in hidden cavities on ascent, as well as ear and sinus pain on descent. These will be described under their respective headings in this Manual.

Pressure Chambers are used to initiate the increased atmospheric pressures beneath the surface of the sea, or the reduced pressure above sea level, and are being built for many Naval Stations, as well as at Army Stations.

RELATIONSHIP OF TEMPERATURE, PRESSURE, AND EXPANSION OF GASES TO ALTITUDE



Comparison with Pressures Found in Diving. For every 33 feet below the surface of the water the body passes through one atmosphere pressure. So the pressure upon a diver 100 feet down would be 100 ÷ 33 = 3 atmospheres plus one atmosphere above the earth's surface or 4 in all. In square inches, this would be 15 x 4 or 60 square inches. In millimeters of mercury 4 x 760 or 3040 mms. So, by pumping 4 atmospheres into a tank, this pressure could be imitated.

It is also noted that, while 33 feet under water creates 1 atmosphere, the weight of the air all the way from sea level to the heavens weighs only one atmosphere. So, while submarine work deals with multiple atmospheres, aviation medicine deals with one atmosphere or less. Accordingly, if we suck ½ of the air out of the Pressure Chamber, we shall have created ½ an atmosphere or ½ of 15 lbs. per square inch (7½ lbs.) or ½ of 760 mms. (380 mms.).

Law Of Partial Pressure. We have said the pressure exerted by the air above us represented one atmosphere or 760 mms. of mercury; but of this, what concerns us most is the individual pressures of the vital part oxygen, the important gas, carbon dioxide, and the useless gas, Nitrogen. These can be easily determined by making use of Dalton's Law of Partial Pressures: "The Total Pressure of a Gas system is made up of the sum of the partial pressures of individual gases in that system." Since we know the composition of air -

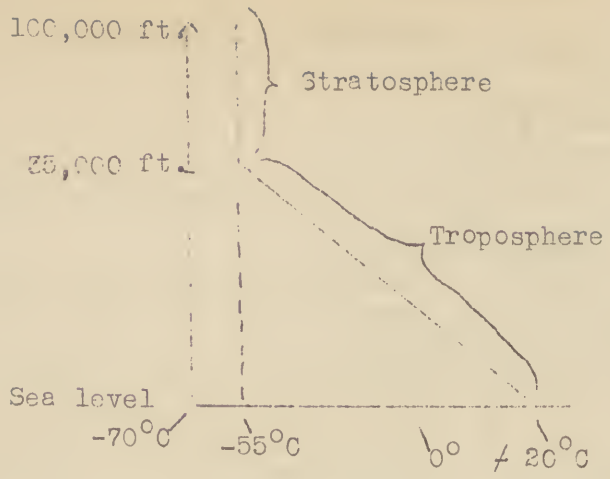
O_2 - 20.93%
CO_2 - .03%
N_2 - 79.04%

that part of the 760 mms. pressure resulting from oxygen at sea level will be 760 x 20.93 or 159 mms. and from nitrogen 760 x 79.04 or 601 mms. At 18,000feet it will be -

Oxygen 380 x 20.93 or 79.5 mms.
Nitrogen 380 x 79.04 or 300.2 mms.

TEMPERATURE. It is generally known that low temperatures prevail on tops of mountains, and in high altitude flying. Indeed, it is the other great factor along with reduced pressure which threatens the effectiveness and life of the Aviator.

The temperature on the ground ranges from 15° - 20° - 30° centigrade (60° - 68° - 84° Fahrenheit) and drops 1° centigrade for every 600 feet we ascend, up until 35,000 feet is reached. Above it is found to be -55° C. and above 35,000 feet to infinity, the temperature remains at -55° C. and does not change. This unchanging zone is known as the STRATOSPHERE, and the changing zone up to 35,000 feet as the TROPOSPHERE.



A few temperatures corresponding to altitudes are set forth in this table.

ALTITUDE	
Sea level	+15°
10,000 ft.	- 4.8°
20,000 ft.	-24.6°
30,000 ft.	-44.4°
35,000 ft.	-55.0°
and upwards	-55.0°

The effect of these lowering temperatures upon aviation personnel is well shown in this interesting table constructed by Major Armstrong of the Army in 1936, from observations made upon 35 pilots and observers who made frequent flights in cold temperatures in open cockpit airplanes.

(See table from Armstrong - next page)

As can be seen there is a direct effect of cold on the intellect, and the emotional state is effected indirectly by several factors. States Major Armstrong, "Most pilots lose some degree of confidence while wearing aviator flying clothing, being conscious of the fact that they are not then so able to properly control the airplane, operate equipment, or "bail out" in an emergency. Heavy flying clothing adds at best 12 lbs. weight and considerable bulk. The constriction, restraint, discomfort, and weight serve as a constant annoyance and detracts attention from the mission at hand. One of the most serious effects is the psychic reaction to physical discomfort. As cold increases we find progressive mental distress, loss of morale, indifference or distaste for the mission, lethargy, and finally stupor and death."

Estimated loss of pilot efficiency from cold temperatures in open aircraft.

Temperature	Efficiency		
	% loss	Total % remaining	
°F			
50	0	100	None
40	10	90	The winter flying suit, boots and light gloves are usually worn at this temperature.
30	10	80	Heavy winter flying gloves are substituted for the light gloves.
20	3	77	The face mask is used which tends to cause goggle fogging, restricts the visual field, and is uncomfortable.
10	7	70	Hands cold. Extra clothing added under the flying suit.
0	2	68	Hands and feet cold. Moderate chilling of the body.
-10	30	38	Goggles frost over with 50 to 100% loss of visual field. Feet and hands become painfully cold.
-20	5	33	Marked physical and mental distress from cold.
-30	10	23	Acute physical and mental distress from cold.
-40	10	13	Loss of morale, distraction, acute physical suffering, muscular sluggishness and incoordination, tendency to stupor.

Law Relating to the Effect of Temperature Upon Volume.

In addition to the effects of pressure upon volume, it must be remembered that temperature also affects it. Charles' Law states that changes in volume are directly proportional to changes in temperature in absolute units. In absolute units 273° equals 0° Centigrade, for physists have shown that a volume of gas at 0°C. increases 1/273 of its volume for each increase of 1°C. and decreases the same amount for each 1°C. decrease. If the temperature were to fall to -273° the volume would be 0. Thus we can see that + 20°C = 273° + 20° or 293° absolute, while - 30°C = 273° - 30° or 243° absolute.

The Formula representing this law is:

$$\frac{\text{Original Volume}}{\text{Original Temperature (in absolute units)}} = \frac{\text{New Volume}}{\text{New Temperature (in absolute units)}}$$

Abbreviated, $$\frac{V}{273 \pm T} = \frac{V}{273 \pm T}$$

Example: We have 100 liters of air at 20° C. How much will there be at 30° C.? Substituting in the above formula:

$$\frac{100}{273 + 20} = \frac{V'}{273 + 30} \quad \text{or} \quad \frac{100}{293} = \frac{V'}{303}$$

Therefore V' equals 103.4 liters (answer)

Based upon this Law is the expansion of air in fast moving automobile tires, the phenomenon of updrafts and downdrafts, air currents about coasts and mountains, in fact much of the whole science of aerology.

ALVEOLAR AIR. Having considered the qualities of Atmospheric Air, we now move on to the Air in our lungs, known as Alveolar Air. It is called this, because it refers to the air in the very tiny air sacs at the very ends of the bronchial tree, called Alveolar Spaces. It is known that the windpipe (Trachea) divides into two main bronchi (one to each lung) and these, in turn to smaller bronchi. Subdivision and subdivision occurs and the smaller tubes are called Bronchioli. At the ends of these one finds the Alveoli. The covering of these is a very fine, delicate, thin membrane through which gases of the air must pass to get into, or out of the thousands of tiny capillary blood vessels which are wound around about them. Furthermore, this membrane has many infoldings so as to increase the surface area exposed to the air coming into the alveolus and thus provide a greater area over which the exchange of gases between the alveolus and blood can occur. It is estimated that, if all these alveoli were unfolded and laid out flat, the total surface to which the blood is exposed would be as large as a tennis court.

Composition. Since the alveolus is the exchange station of gases coming in and out of the blood, the samples of air taken from it show some variance with the percentages found in the outside air, as one would expect from the mixture. Carbon Dioxide is being delivered up from the blood in large quantities, so its percentage increases at the expense of oxygen. Furthermore, there is considerable more moisture, gathered up by the air in its passage via our mouth and bronchial tubes. The pressure exerted by this water vapor amounts to 47 mms. of mercury and is present, regardless of place or altitude (air at body temperature - 98.6° F. - is saturated with it); but, of course, it uses up just that much of whatever total driving force or pressure exists, whether it be 760 mms. at sea level, 380 mms. at 18,000 feet, or 190 mms. at 34,000 feet.

Atmospheric Air			Alveolar Air
Oxygen	20.93%	- - - - - -	15%
CO_2	.03%	- - - - - -	5%
Nitrogen	79.04%	- - - - - -	80% - about the same
Water Vapor-small amounts- - -			always 47 mms. (saturated)

Relative Partial Pressures When Breathing Air and When Breathing 100% Oxygen. Now let us consider what driving force we may expect from oxygen in the alveoli as a result of these new percentages. First deducting our ever present 47 mms. for water vapor, we apply the law of partial pressures.

Sea level	18,000 feet	34,000 feet
760 mms.	380 mms.	190 mms.
-47 mms.	-47 mms.	-47 mms.
713 mms.	333 mms.	143 mms.
x15%	x15%	x15%
105 mms.	50 mms. of	22 mms. is
This is the normal driving force of oxygen required for healthy life.	Driving force for oxygen.	Partial pressure of oxygen here.

A 22 mm. partial pressure of O_2 is incompatible with life and 50 mms. (18,000 feet) cannot be tolerated for any long period.

When an oxygen mask is applied, properly adjusted, and fitting tightly, it excludes that large percentage of pressure accountable to nitrogen (80%) and so leaves available this portion for additional oxygen pressure. Let us consider now 34,000 feet in this light. To find the net force available for oxygen, we first deduct water vapor (190 - 47 = 143). Then we have also to consider the partial pressure of CO_2. This would be at sea level (713 x 5% = 36). Now it should be noted that although one would expect the partial pressure of CO_2 to be 5% of whatever pressure existed at these levels, this is not the case. To maintain normal breathing, nature has arranged to maintain this 36 mms. regardless of the prevailing pressures. This must also be deducted in our process of determining the net pressure. Therefore, it is -

190 - 34,000 feet
-47 - water vapor tension or pressure
143
-36 - CO_2 tension or pressure
107 mms. pressure left, all of which can be allotted to oxygen, for the mask eleminates nitrogen.

It is quickly seen that if at sea level 105 mms. is the partial pressure of oxygen designed to drive this gas into our blood in sufficient concentration for normal health, we have created these same conditions, 107 mms. at 34,000 feet by breathing pure O_2 and eleminating the useless 80% nitrogen pressure which ordinarily would enroach upon the total. Thus at 34,000 feet with extra oxygen we have twice the driving force available at 18,000 feet (50 mms.) without extra oxygen.

When we reach 41,000 feet the total pressure is 134 mms.

134 mms.
-46 mms.-water vapor pressure
87 mms.
-36 mms.-CO_2 pressure
51 mms.

51 mms. is the total residual left for oxygen, which even though coming from a mask in 100% concentration, provides the same inadequate driving force as did the 15% oxygen in ordinary air at 18,000 feet (50 mms.). Accordingly it is seen that if a man tolerates 18,000 feet without extra oxygen, he should be able to stand 41,000 feet for a short time with extra oxygen. This, in fact, is our procedure for high altitude classification at Pensacola.

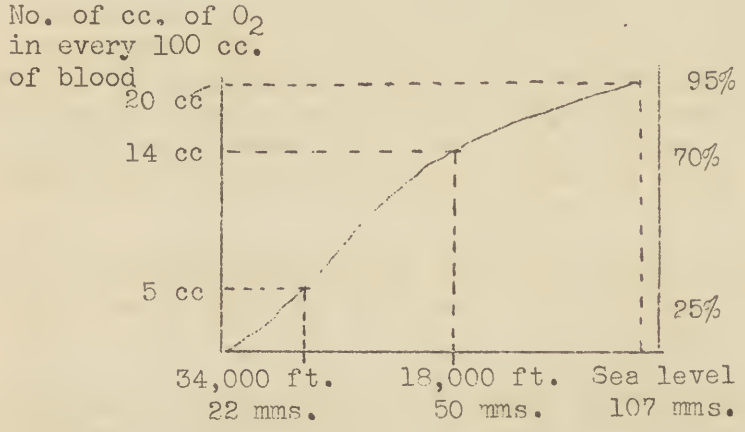
The reasoning follows that at 63,000 feet where the total pressure is 46.9 mms. it would be entirely taken up by water vapor (47 mms.).

No mask fits tightly enough to conduct gas at a pressure in excess of the total pressure prevailing at that particular level. Only by the use of pressure suits or sealed cabins, where with compressors and superchargers thin air can be forced to pressures approximating those of sea level, or near sea level, can altitudes in excess of 35,000 feet be attempted in safety. Stratoliners are built with pressure cabins, but neither these nor pressure suits are practical for military flying, for a single perforation of either (as by a bullet) destroys what pressure has been developed in them.

OXYGEN SATURATION OF THE BLOOD. Realizing finally that it is the alveolar driving pressure of oxygen which counts, we must now consider how much is carried by the blood under these different pressures.

The blood contains about five million microscopically small biconcave discs called Red Blood Cells or Corpuscles in each cubic millimeter. The corpuscles contain a blue iron compound known as Hemoglobin whose purpose is to carry oxygen.

As the corpuscles flow over the alveoli, the oxygen which has passed through the alveolar membrane is picked up by the hemoglobin in 15/100 of a second. This combination is a brilliant red color, and so the blood in our arteries is red. When the blood reaches the internal organs and tissues, the hemoglobin just as quickly gives up its load, and of course immediately become blue again. The veins returning this blood to the lungs therefore are blue. It follows, of course, that if there is insufficient partial pressure of oxygen to force the usual amount into the blood, the hemoglobin will be insufficiently saturated, and will be more or less blue even in the arteries. The following curve known as the oxygen-hemoglobin dissociation curve shows how many cubic centimeters of oxygen are dissolved in 100 cc. of blood under different partial pressures, and also the % saturation of the blood under these same pressures.



Thus it is seen that at 18,000 feet the blood is 70% saturated and 30% unsaturated. This is why the finger nail beds, ear lobes, lips, and skin appear so blue and become pink again as soon as additional pressures of oxygen are again available whether from a mask or at lower altitudes.

To counteract this effect, breathing becomes somewhat deeper, the heart speeds up to get the reduced load of oxygen to its destination more often, and, if one remains for any length of time on high mountains, more and larger red cells are manufactured (up to 7-8 million per cc.) and the load of hemoglobin each carries is increased. Such a process is called acclimatization, and in order not to lose these conditions, the Germans have established Rest Camps in the Alps where resting and recuperating pilots can stay.

TISSUES. We have now come to the final destination of our oxygen, as the blood delivers it to the tissues and organs. Here it will be received and utilized, unless prevented from so doing by disease or injury. Oxidization of the food

products transported there occurs, producing body heat and carbon dioxide and other breakdown products which are eliminated from the body via the breath, the kidneys, the bowels, and the skin. The CO_2 leaves the body by the reverse of the course through which the oxygen enters.

High pressures flow in the direction of lower ones, and the following figures will give an idea of the gradient;

	Atmospheric Air	Alveolar Air	Blood	Tissues
Oxygen	159 mms. ——→	107 mms. ——→	105 mms. →	40 mms.
	0.23 mms. ←——	35 mms. ←——	40 mms. ←	56 mms. - CO_2

Additional evidences resulting from the failure of oxygen to reach the tissues will be discussed under anoxia.

MECHANISM OF BREATHING

Breathing is the mechanism by which the atmospheric air is taken to the alveolar spaces, and by which the CO_2 delivered by the blood to the lungs, is removed from the body.

Control by Carbon Dioxide. Breathing is controlled by nerve centers in the brain stem (Medulla). One center has to do with Expiration, and a second directly below it, with Inspiration. These centers can be controlled by many influences as will be shown presently, but by far the most important of all is CARBON DIOXIDE, the gas produced as a result of combustion in the body tissues. In the alveolar air at sea level we have already said it amounted to about 5% or 36 mms. pressure. Any increase in this speeds up breathing and deepens it to eliminate the surplus. Thus, we puff harder during exercise when the combustion in our body cells has increased. Likewise a decrease in the alveolar air slows down breathing, that less shall be blown off and consequently more allowed to accumulate. The mechanism is so delicate that an increase of 1 mm. pressure in the lungs produces a 5% increase in lung ventilation (400 cc. per minute) and increase of 2 mm. doubles the normal ventilation, and 3 mm. triples it. On the other hand, a reduction of alveolar air CO_2 by only 2 mms. pressure produces temporary cessation of breathing. By this means the body is kept in exact and perfect proportion.

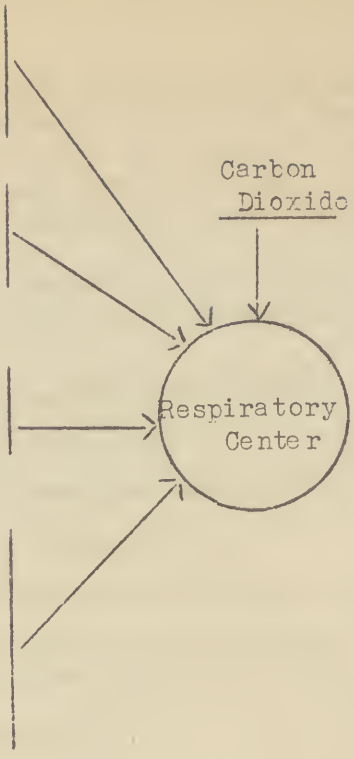
Control By Other Nervous Mechanisms

1. Glossopharyngeal nerve, Superior Laryngeal nerve - prevents your breathing in while swallowing or speaking.

2. Sensory nerves will stimulate or prevent breathing when recording cold, pain, a horrible sight, a loud noise, fear, love, or anger.

3. Higher centers of the brain - enabling you to hold your breath for awhile. When the CO_2 reaches 7% you have to breath.

4. (a) Vagus nerve is stimulated as the alveolar wall is stretched during inspiration and sends the message to the respiratory center to exhale.
(b) Vagus nerve is stimulated as the alveolar wall collapses, and sends a message to the Respiratory Center to inhale.



Constancy of Carbon Dioxide. This CO_2 in the alveolar air remains the same regardless of the number of breaths per minute, for, if very rapid, they will be shallow; and if unduly slow, they will be deep. Also it is unaffected by the amount of work done, for the more CO_2 produced, the greater the amount exhaled. Finally whether the total pressure be 760 mms. or 2 atmospheres, or 5, or $\frac{1}{5}$, the CO_2 alveolar tension will not vary from 36 mm.

Because of the powerful effect of CO_2 in stimulating breathing, most anaesthesia machines include 5% CO_2 as well as the anaesthesia, and resuscitation machines include 5% CO_2 with the oxygen.

Mechanics of Breathing. The actual mechanism or mechanics of breathing consist of the expansion of the chest effected by (1) the intercostal muscles pulling the ribs and (2) the movement of the diaphragm. The pairs of ribs move according to this schedule -

Ribs	Anterior-posterior Movement	Transverse Movement
1st	↗	0
2nd, 3rd, 4th, 5th, 6th	↗	↗
7th, 8th, 9th, 10th	-	↗
11th, 12th	0	0

It is apparent, therefore, that most of this movement is the result of 2nd through 6th pair of ribs.

The diaphragm is a large muscle sheet dividing in 2 halves and separating the abdomen from the chest. Normally it is dome shaped, the dome extending upwards. As the muscle contracts, it descends, acting as a plunger being pulled out of the chest cavity, and so sucking in air through the nose and mouth. Its area is about 300 square centimeters. If it descends 1 cm. 300 cc. of air will be drawn in; if it descends 3 cc., 300 x 3 or 900 cc. will be brought in.

Classification of Air in the Lungs. The air in the lungs can be divided into 4 pa rts:

1. Tidal Air passing back and forth with ordinary regular breathing - 300 - 400 cc.
2. Complemental Air, that additional amount you can draw in when you consciously try - 1000 - 1500 cc.
3. Supplemental Air, that additional amount you can blow out when you consciously try - 1500 - 2000 cc.
4. Residual Air, that amount remaining in your lungs after you have blown out all possible, and which could only be removed by getting the lungs out of the chest and wringing them out.

The Total Capacity therefore is -	The Vital Capacity is -
1500 cc. Residual	400 cc. Tidal
400 cc. Tidal	2000 cc. Supplemental
2000 cc. Supplemental	1500 cc. Complemental
1500 cc. Complemental	3900 cc. Vital Capacity
5400 cc. Total Capacity	

ANOXIA

We now come to the 3rd part of our subject; the results of insufficient oxygen. In Medicine, this is called Anoxia, a Greek word combined from "An" meaning "absence of" and "oxia" meaning "oxygen".

CONDITIONS PRODUCING ANOXIA. This can be produced by disturbance of normal conditions at any of the following states:

Atmospheric Air	Alveolar Air	Transportation of O_2 (Blood)	Tissue Metabolism
1.Lack of O_2 2.Insufficient Barometric pressure. 3.Tracheal obstruction.	1.Edema & Fibrosis from chlorine gas, Tbc.pneumon. 2.Partial unventilated areas of lung. from shock, pneumo-thorax pneumonia, or low breathing.	Normal 21cc.O_2 per 100 cc. blood. Reduced by - Anemia Hemorrhage CC, heart failure, shock	Bacterial toxins, narcotics, etc. Absence of the enzymes CC-CARBOXYLASE which is quickly destroyed by alcohol. This is derived from Vit. B & is essential to allow the O_2 to pass thru cell membrane.

CARBON MONOXIDE. Carbon monoxide has 212 times the capacity to combine with hemoglobin that oxygen has; therefore, the partial pressure of oxygen would have to be 212 times higher than that of CO to compete for the hemoglobin on even terms. In order to displace this CO with any speed, it can be seen that the oxygen would have to be administered under pressure. Accordingly in addition to artificial respiration and oxygen, the practical treatment is to introduce more oxygen carrying units by transfusion.

Subjective Symptoms of Anoxia. The following subjective symptoms in the order of their frequency from above downward, are listed for the various altitudes by Major Armstrong:

12,000 feet	14,000 feet	16,000 feet
Sleepiness	Headache	Headache
Headache	Altered Respirations	Alt. Resp.
Altered Respiration	Sleepiness	Psych. Imp.
Lassitude	Psycho. Impairment	Euphoria
Fatigue	Lassitude	Sleepiness
Psychological impairment	Fatigue	Lassitude
Euphoria (Punch Drunk)	Euphoria	Fatigue

During the early part of this War many bombing missions undertaken by the R.A.F. had to be discontinued because some of these symptoms and also "bends " (described later) developed in 2 or 3 members of the crew. Subsequently, to overcome this, the Pressure Chambers were introduced, and men susceptible to these incapacities were filtered out.

INDIVIDUAL CEILINGS. By virtue of a combination of many unknown factors built into the human body largely as a result of heredity, a man's true ceiling is built into him. No two people have the same altitude tolerance. Furthermore, individuals vary from time to time, but, in general, the following are true:

1. Body Build. There is no relation between this and altitude tolerance. The well built muscular oarsman may require oxygen at a lower level than the puny non-athletic individual sitting beside him, but -

2. Good Physical Condition as produced by regular sleeping and eating hours, regular exercise and freedom from worry, gets the body into the habit of compensating. Most hearts compensate for the diminished supply of oxygen by increasing their rates from 6 to 40 beats per minute, - and, meeting this demand daily, finds nothing unusual in answering the call to deliver the inadequate oxygen supply at a faster rate.

3. Loss of Sleep produces a marked falling off of ceiling. A German flight surgeon (Lottig) has demonstrated conclusively that even moderate fatigue brought on by securing only 4 hours of sleep, markedly diminished the altitude resistance of experienced pilots when they were tested in the low pressure chamber, and that this resistance to low oxygen tensions in the respired air markedly increased when 8 hours of sleep

were secured previous to the test. The likely explanation of it is that the brain and body cells have not been completely cleared of the breakdown products from previous metabolic activity, which interferes with the admission of oxygen to the cells, or utilization of it by them.

4. Alcohol, which frequently is associated with loss of sleep, has a marked effect. Depending on the amounts used, it can reduce one's ceiling to zero. The effects of alcohol are really those of anoxia, for it destroys an enzyme in the cell essential to the admission of oxygen. This enzyme is called Co-carboxylase, and is derived from Vitamin B. Thus, regardless of how much oxygen is in the blood, if it cannot be admitted to the cell, the effect will be quite the same as if the reception were normal though the supply inadequate. From this it can be readily seen that, given both an inadequate supply, and impaired passage to the cell, the likelihood of enduring high altitudes successfully is small. The smooth flow of nervous impulses to the muscles is interrupted, the hands tremble, coordination is impaired, reaction times slowed down, and mental activity depressed.

For these reasons, Pan American and Commercial Air Lines pilots are forbidden alcohol within 48 hours previous to a flight, and are also checked up on for daily moderate exercise.

5. Food. An empty stomach means that the blood sugar is on the low side of the normally accepted range (80-120 mg. per 100cc. of blood). Neuroligists know that in persons susceptible to epileptic fits, a convulsion can much more easily be produced during a fasting state. Furthermore the suspiciously pathological "Delta" waves recorded by brain wave apparatus (Electroencephalograph) on many experienced pilots known to be perfectly healthy and with excellent records, were quickly eleminated by feeding them Karo syrup previous to the test. It follows, therefore, that the brain cells and nerves become more steady if the blood sugar is at higher levels. Accordingly, flying on an empty stomach is not advised.

6. Drugs, such as sulfanilamide, sulfapyridine, sulfathiazol, etc. which in large amounts interfere with the oxygen carriers of the blood, and hypnotic drugs which depress the action of the nerve cells, obviously lower the ceiling of the pilot.

7. Finally all such emotional states as fear, anger, despondency, sorrow, and worry, throw great strains upon the autonomic nervous system of the body and depress one's altitude tolerance. The heart quickens, blood pressure rises, muscles are tense, body metabolism increases, and sleep is interrupted. Such events require more oxygen and so lessen the margin of reserve. It is frequently possible to predict those who are likely to fail in the low pressure chamber by the anxiety they exhibit when entering it.

HOW AND WHY MEN FAIL. During the last War, classification for high altitude flying was conducted by having men breathe at sea level from a bag containing ordinary air, until they used

up so much of the oxygen that they showed symptoms. The gas in the bag was then analysed, and the oxygen content remaining was matched with the corresponding altitude. This was the physical fitness test used at that time, to some extent as our Schneider Index is today. This test, of course, gave no indication of how long a man could stand a given altitude, and furthermore it was done under, conditions of absolute rest sitting in a chair in a doctor's office, which means that the actual ceiling the man could reach in a plane would be considerably lower. Of the 33% who could stand less than the equivalent of 20,000 feet -

46% were fainters (circulatory collapse)
54% were non-fainters (but mentally incapacitated)

Fainters. Those who faint, do so either (1) because their blood pressure collapses as a result of insufficient oxygen to the center in the brain which controls the tension of the smaller blood vessels throughout the body, or (2) because the heart is unable to tolerate the additional strain of 20-40 additional beats per minutes in the effort to get the insufficiently oxygenated blood to the ever demanding tissues.

These pilots develop a lemon yellow or pale greyish color, may occasionally show convulsive movements and perspire profusely, and collapse. They may regain sufficient consciousness around 5 or 6 thousand feet to bring their plane out of a spin and land safely. A recent pilot of the Montreal-Britain ferry bomber service tells during one crossing of how his Engineering officer, working in the tail of the plane, lost his oxygen and became unconscious, following which his passenger, radioman, and navigator all shared a similar fate, because of pulled off oxygen nipples or pinched off lines as each went to the rescue of the others. One tried to hold his breath and rush back; of course he failed. They were all finally rescued by the co-pilot.

About 1% of this group fail because they cease breathing. By excessively heavy and fast breathing they have blown off so much CO_2 that the Respiratory Center of their brain is inadequately stimulated, or this center may be insufficiently bathed in blood containing necessary CO_2 to stimulate it. Obviously to such, artificial respiration must accompany the administration of oxygen in order to get the latter into the alveolar spaces.

Non-Fainters. The large group who become mentally incapacitated are in even a less enviable position, for they are goaded into more and more danger by their complacency and the enjoyment of the slap-happy, anoxic intoxication. The effects of low pressure upon the brain cells are analagous to the effects of gas anaesthesia or carbon monoxide poisoning in early stages. In each instance oxygen in sufficient

amounts is not available to the brain cells and in consequence their functions in the form of thoughts and nervous control are impaired. Since the brain is affected first, pain danger, and suffocation are not recognized.

One feels sleepy, slap-happy, irritable, or inert, over-confident, or omnipotent. Judgment and concentration are lost; sounds, lights, or feelings are ignored or misinterpreted and things done, or left undone, during these periods are not recorded in one's memory. Actions are often bizarre and irrational. Coordination is impaired. Re-read the description of Tissandier at the beginning of the Section on Physiology.

Almost every old pilot has stories to tell on this subject. In the low pressure tank after 10 minutes at 18,000 feet without extra oxygen, one cadet busily crossed out the required letters of his psychological test with the eraser end of his pencil and passed in the paper with full confidence of an excellent performance; while another was so absorbed with the inward joys of anoxic intoxication that he could not even be persuaded to attempt the test at all.

In bombing practice at 24,000 feet one pilot was reported to have bombed the ship towing the target; while in a tank at an altitude simulating 22,000 feet the great and dignified scientist Haldane of Oxford tried to observe his lips with the reverse side of a mirror and entered profanity in his log when his colleagues outside disturbed his complacency by lowering the altitude.

Additional, although less dramatic, signs of anoxia with which one should be familiar are:

1. Blueing of the finger nail beds, lips, ear lobes and skin, as the hemoglobin of the blood becomes less saturated with oxygen, thus making more conspicuous the natural blue color. This does not signify necessarily immediate danger, whereas -

2. The Yellowish or Pale Grey Shade indicates a collapse of blood pressure and circulation.

3. The apparent dimming of lights and loss of peripheral vision as the outer parts of the retina become less capable of receiving light stimuli. One pilot reported that he found it impossible to concentrate on more than one instrument at a time, whereas it is a common experience for all to observe that lights appear immediately brighter once the oxygen mask is applied, although the gradual dimming had not been noticed. Indeed, we have heard only recently that at 6,000 feet, without extra oxygen, night vision is markedly impaired.

4. Nausea and pounding of the heart are common experiences. Increase of heart rate has been previously discussed, and it is obvious that a diseased heart could not stand the extra strain without strong likelihood of failure.

5. Tremor and unsteadiness of hands are very frequent, while changes of personality follow closely the patterns of alcoholism. Men become depressed, exhilerated, self absorbed, or pugnacious, revealing the basis underlying characteristics of their nature as the censor of cultivated behavior is removed.

6. Loss of hearing and misinterpretation of sounds occur often. Pilots report their motors had a muffled sound when actually it was their perception of the sound which was altered.

In 1936, while flying over Newark at about 36,000 feet in a test flight from Kansas City, Commander Tomlinson, reports inadvertently taking a breath of air during a radio conversation and very nearly passed out as a result. It was nearly 5 minutes of sucking oxygen before he regained sufficient strength to speak. Within this period he interpreted his signal as increasing and continued flying East until the combination of Boston and Albany signals gave him his position as out over the Atlantic. Actually the signal had been a decreasing one, but as he was rising from a low level of consciousness, it naturally kept sounding louder. As he said, this misinterpretation nearly resulted in a tragedy for he ran out of gas at the New Jersey coast and glided into Princeton with a dead stick, ½ mile visibility and 200 ft. ceiling.

7. Loss of concentration is noticed by all and there is a general slowing up. The effects show up in reaction times on simple psychological tests. For instance, if a man is asked to push a key whenever he sees a light flash, he responds at

sea level in .33 seconds
18,000 feet in .33 seconds
28,000 feet in .45 seconds.

However, when he has before him 4 lights in a row with an answering key for each light and answers the particular light flashing, the times are:

sea level .40 seconds
18,000 feet .50 seconds
28,000 feet .80 seconds.

This latter is a more complex situation, requiring co-ordination and attention, and more analogous therefore to the situation in a plane where there are all kinds of things to check and do. In this case the man felt more efficient and boasted of his speed and accuracy, yet the elapsed time was twice as long at 28,000 ft.

8. Fatigue from prolonged exposure to low pressures is marked and lasting. It is an "anoxic" hangover and renders a pilot unfit for several days. Usually it is accompanied by severe headaches, lassitude, and irritability. It results from the body cells being starved of oxygen for too long a period. To fly under such conditions would be dangerous indeed.

Thus we see the wisdom of order No. 42-42 of the Bureau of Aeronautics, if men in the service are to be kept fit from day to day, with their full faculties of sight, hearing, coordination and judgement.

These orders are in part:

1. Oxygen shall be used in flights over 15,000 feet until returned to this level.
2. Oxygen shall be used in flights of 12,000 feet for two or more hours.
3. Oxygen shall be used in flights of 10,000 feet for four or more hours.

PARACHUTE JUMPS. At 40,000 feet without extra oxygen a man has 30-60 seconds of consciousness, 2-3 minutes at 35,000 feet and 5-7 minutes at 25,000 feet. In free falls, a man drops 12,000 feet per minute and with a parachute 2000 feet per minute. In both cases he falls faster in the higher thin air and slower in the low heavier air, but these figures are approximate. With this information, it is easily understood that if a man pulled his rip cord after jumping at 40,000 feet he would die from anoxia before reaching safe levels. Also, if he attempted a free fall before opening his chute, he could not fall far enough during the period of consciousness to enable him to reach safe levels, and would be unconscious at the time the cord should be pulled. For these reasons high altitude fliers are supplied with a small pocket oxygen flask which they turn on as a first procedure after deciding to leave the plane.

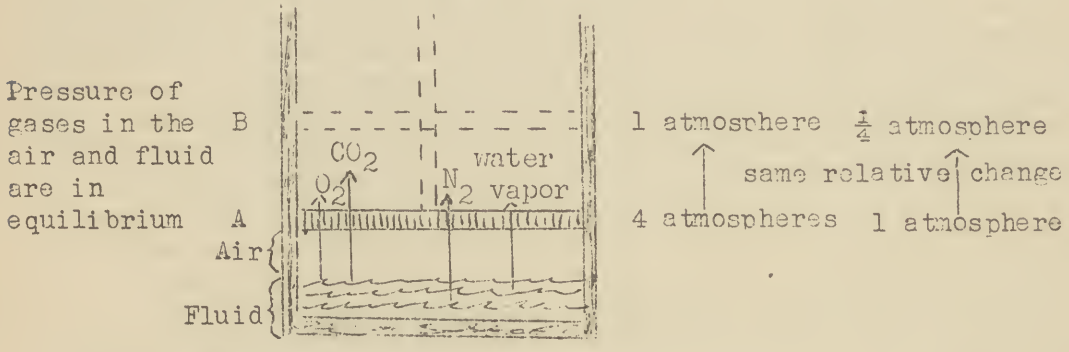
AEROEMBOLISM (Caisson's Disease)

Definition. An embolism is anything being swept along in the blood stream by the current of blood. Most frequently it is a piece of clot broken off from a wound or injured vessel. It may be air or gas bubbles, fat. Blood vessels become smaller as the distance from the heart increases, and when the embolus becomes bigger than the vessel, it blocks it, thus cutting off the flow of blood to parts beyond. Organs and tissues deprived of blood produce pain, and, of course, eventually die. Therefore, the seriousness of an embolus depends upon the place it strikes. In the vessels of the heart, brain, or lungs, it may be critical; in the muscles or skin, of no significance.

The release of gas bubles in the blood stream is exactly similar to the release of bubbles in a ginger ale or beer bottle when the cap is removed. In the manufacture of these

carbon dioxide is forced into these bottles at the time of filling under pressure and goes into solution. When the cap is removed, the gas comes out of solution due to the lower pressure of the outside air. As the cap is replaced, pressure is built up until the gas above and that dissolved in the solution are in equilibrium; the bubbling ceases.

We always associate this disease with the rising of divers to the surface, or others working below water, in tunnels etc.--under compressed air, at a pressure equal to that of the depths at which they work. If they are working at 4 atmospheres (100 feet below the surface), a pressure of 4 atmospheres must be supplied, else their suits will collapse and water enter. Consequently, 4 times the amount of gases from the air will be dissolved in the blood and tissues.



Gases of the air dissolved in the fluid

In the diagram we have a piston compressing air over the surface of water. Oxygen, CO_2, and Nitrogen will be dissolved in the water. As we raise the piston, varying amounts will begin bubbling out of solution. Now gas bubbles do not come off at any fixed point on a pressure gauge, but according to the relative change with reference to the actual pressure on hand. The general rule for diving is that it is as safe to decompress from 8 to 4 atmospheres, as it is from 2 to 1 atmospheres; i.e. that it is safe to half the absolute pressure.

It follows that one can safely decompress from 1 atmosphere to $\frac{1}{2}$ (18,000 feet) and that beyond that point bubbles will appear in the body. Nitrogen bubbles have been found in the spinal fluid at this very altitude.

In our diagram we have, by pulling the piston up, reduced our pressure through three atmospheres in going from 4 to 1, and through 3/4 of an atmosphere in going from 1 to 1/4, (34,000 feet), but the ratio is the same, 4 to 1. Accordingly, in either case we should expect gases to come out of solution and bubbles to form. And actually they do.

The oxygen bubbles immediately find hemoglobin and enter into combination with it, so they give no trouble.

The carbon dioxide bubbles are picked up by the sodium of the blood and enter into chemical union to form sodium bicarbonate, which is harmless.

But there is nothing to pick up the nitrogen, so many small bubbles join together, become large, and block off blood vessels. Accordingly the word aeroembolism is really incorrect. The condition should be called nitroembolism.

When these bubbles lodge in the abdominal vessels, about the knee, elbow, wrist, or shoulder joints, they induce much pain, bending you over or causing one to splint the affected part. Hence they are called "bends"; if they land under the skin, they irritate the nerve endings causing a tickling, itching sensation, it is known as the "itch"; in the lungs they give a suffocating sensation referred to as the "chokes"; if they land in the spinal cord or brain, a temporary weakness or paralysis of the leg may follow, "the staggers".

About the joints the order of frequency is as follows: knee, finger, shoulder, ankle and hip. The pain begins as a mild ache, resembling a sprain. It does not increase for a while, but after 4-5 minutes rapidly builds up to the point of intolerance. As nearly as can be described it is like a severe toothache transplanted inside the bones of the joint involved. Although bubbles begin forming at 18,000 feet, the speed of their release does not make the onset of bends probable below 30,000 feet, and, as expected, the treatment for this condition is immediate descent, to between 20,000 and 25,000 feet or lower, where the increased pressure of the atmosphere forces the nitrogen back in solution.

The factors influencing them therefore are:

1. The altitude to which you go.
2. The rapidity of ascent.
3. The time remaining at this altitude.

A man ascending slowly will get rid of more and more nitrogen through his lungs, and is less likely to be affected than one ascending to 35,000 feet in 6 minutes; who is almost sure to suffer. Furthermore, the longer a man remains, the more bubbles come off. It is obvious a quick dash up and down would cause no symptoms. It is usually a matter of 10 to 15 minutes before sufficient nitrogen is released to produce them.

At sea level there is roughly 800 cc. of N_2 in the body, and at 40,000 feet approximately 130 cc. Therefore about 670 cc. must be eliminated. Nitrogen has a strong affinity for fat and for an obese pilot its elimination is a slower process.

In England, where rapid climbing interceptor action and long range high altitude bombing have become routine, missions have had to be terminated prematurely so often because of aeroembolism as to justify the testing of pilots and crews in low pressure tanks at 35,000 feet for four hours at a time with extra oxygen. Here our candidates for Carrier Service are held at this altitude with extra oxygen for one hour without previous preparation.

Prophylaxis against "bends" is accomplished by exercising on a rowing machine or stationary bicycle while breathing pure oxygen for 20 to 30 minutes before ascending. The nitrogen pressure of atmospheric air is thereby eleminated and the speeded up circulation helps to wash nitrogen around to the lungs from which it is breathed out. But in aerial warfare, one has no time to prepare, and pilots must be found who are least susceptible. Age is closely associated with this, and the younger the pilot the less likely he is to be bothered. Any fractured bone or injured part of the body seems to be a likely spot for the bends to strike.

To help the pilot get rid of as much nitrogen as possible on the way up, the 4th section of order No. 42-40 of Bureau of Aeronautics is: "When flights of 23,000 feet or above are anticipated, the pilot shall begin the use of oxygen upon taking off".

SECTION VI

CLERICAL

MEDICAL DEPARTMENT FORMS, REPORTS and LETTER WRITING

PAGES 96 to 112 inclusive

THE

HEALTH RECORD

OPENING

A health record shall be opened (issued) for each officer appointed or commissioned and for each enlisted man upon enlisting in the Navy. This record shall be complete in every detail, with special precaution taken as to correctness of name, date and place of birth, finger print, and marks and scars. When complete, this record shall be signed by the Medical Officer conducting the examination.

CUSTODY

The health record of each officer and man shall be retained in the custody of the Medical Officer of the ship or station to which the individual is attached. Records of all personnel shall be checked at least quarterly as to typhoid and cowpox prophylaxis and next of kin. Health records are subject to inspection at anytime by the commanding officer, district medical officer or fleet surgeon, but otherwise they are to be considered confidential.

In case of loss or destruction of a health record, the Bureau of Medicine and Surgery shall be notified, giving the name in full, rank or rate, and date and place of birth. A complete new record shall then be opened.

TRANSFER

Upon transfer of an individual the health record shall be forwarded via official channels to the new ship or station except in such cases as follows:

1. In case of officers ordered to duty where there is no Medical Officer, or granted sick leave, the record shall be forwarded to the Bureau of Medicine and Surgery with an explanatory letter.

2. When ordered before a board for a physical examination, the record shall be forwarded to the president of the board.

3. When ordered to duty in Washington at the Navy Department, Marine Corps Headquarters, Naval Observatory, Army War College, Naval Research Laboratory, Arlington Radio Station or Radio Material School, the record shall be sent to the Commanding Officer, Naval Dispensary, Navy Department, Washington, D. C.

Upon transfer of a patient to a hospital for treatment, the record shall accompany such patient along with his hospital ticket at time of transfer. (See paragraphs 2213, 2214, 2216, Manual of the Medical Department for further instructions.)

TERMINATION

The health record is terminated only under the following conditions:

1. Death.
2. Medical Survey.
3. Desertion.
4. Discharged and not reenlisted.

Upon termination of a health record the complete record is forwarded to the Bureau of Medicine and Surgery.

The COVER (Form H-1): Type in surname in capital letters, then christian names in full. Insert rank or rate in proper place and in case of enlisted personnel the service number. Care should be used in the proper spelling of all names.

The DENTAL RECORD (Form H-4): This sheet shall be prepared in duplicate (duplicate forwarded to Bureau of Medicine and Surgery) when each officer or man is first examined by a dental officer, and thereafter, each dental officer who examines or treats any personnel, shall be responsible for the completeness of the dental record.

The DESCRIPTIVE SHEET (Form H-2): This sheet is to be completely filled in (in duplicate and duplicate forwarded to the Bureau of Medicine and Surgery) by the Medical Officer at time of enlistment, appointment, commission or promotion (except Temporary promotions). Care should be taken in making out this sheet for it is of great importance in identifying deceased personnel, especially those killed in airplane accidents. (See paragraphs 2261, 2262, Manual of the Medical Department for detailed instructions.)

The MEDICAL ABSTRACT (Form H-3): Enter full name, place and date of birth as on cover. Record all vaccinations, prophylaxis, inoculations, blood group, etc. Each entry must be signed by a medical officer. On reverse side record all special physical examinations and eye refractions.

The SERVICE ABSTRACT (Form H-5): Enter full name, place and date of birth. Upon receipt of record make entry of ship or station to which attached and date of arrival - upon detachment enter date. On reverse side make entries of all admissions to the sick list with dates, diagnosis and number of sick days in each case.

The MEDICAL HISTORY (Form H-8): Enter full name, place and date of birth. These sheets shall be numbered consecutively in the upper right corner. Record here all admissions to the sick list, results of physical examinations and any other data pertaining to the medical history of the individual. These sheets are forwarded to the Bureau of Medicine and Surgery annually on all regular officers upon completion of their annual physical examination, and on enlisted personnel upon reenlistment.

THE

DIAGNOSTIC NOMENCLATURE

GENERAL INSTRUCTIONS

(a) Diagnosis Numbers and Class Numbers.

The last two digits of a diagnosis number identify it as a title within the class indicated by the one or two preceding digits.

(b) Diagnostic Titles.

Diagnostic titles are listed in two ways:

1. By classes.
2. By alphabetical arrangement.

Wording not specifically required shall not be included as a part of the diagnostic title.

(c) Diagnosis Undetermined.

For elasticity, the title Diagnosis Undetermined is provided under three headings:

1. Diseases and conditions - 2122
2. Injuries - 2518
3. Poisonings - 2600

When the title Diagnosis Undetermined is used, the suspected disability shall be entered in parentheses immediately following. When the nature of the disability is determined, the case shall be changed from Diagnosis Undetermined, by reason of ESTABLISHED, and READMITTED (RA), under the established diagnosis.

This title may be used for admission to the sick list and transfer of patients when circumstances do not warrant an immediate diagnosis. A diagnosis may be changed to Diagnosis Undetermined when a patient is already on the sick list and and undetermined disability arises.

Diagnosis Undetermined shall not be used to report an admission when the case is retained and the diagnosis established at the same ship or station. Under no circumstances shall a case Diagnosis Undetermined be disposed of as DUTY (D), DIED (DD), INVALIDED FROM SERVICE (IS), or TRANSFERRED (T) to sick leave. Only in the following ways may a patient be disposed of under the title Diagnosis Undetermined:

1. Transferred to hospital.
2. Diagnosis Changed.
3. Desertion.
4. Continued to next year.

(d) No Disease (2143)

The title NO DISEASE is to be used only for individuals who, for any reason, must be carried on the medical department returns for rations, as suspects, or as contacts, who do not claim to be and are not regarded as sick. When this title is used the reason or condition for its use shall be recorded in parentheses immediately following the title as: NO DISEASE (SPINAL PUNCTURE); NO DISEASE (MENTAL OBSERVATION).

When a person is admitted to the sick list under NO DISEASE and is later discovered to have, or have had, a disability of sufficient gravity to have caused his admission at that time, the diagnosis shall be changed by reason of ERROR to that of the disability.

(e) Abbreviations For Taking Up and Disposing of Cases.

A - - - - - Admitted (new admission)
ACD - - - - - Admitted contributory disability.
RA - - - - - Readmitted.
__ - - - - - Remaining (from previous year).

D - - - - - Duty
C - - - - - Diagnosis changed.
DD - - - - - Died
IS - - - - - Invalided from service.
RAN - - - - - Deserted.
T - - - - - Transferred.
__ - - - - - Continued (to next year)

Interpretation of above terms

(A) ADMITTED: All new admissions for disabilities which have developed or been incurred since entry into the service and which bear no relation to a disability for which the patient has been previously taken up on the sick list shall be taken up as ADMITTED.

(ACD) ADMITTED CONTRIBUTORY DISABILITY: All first admissions on account of complications, including final disabilities, shall be taken up as ACD. No case shall be taken up as ACD unless there has been a previous admission to the sick list for the disability of which the complication is a result. Such a complication shall be taken up as ADMITTED (or if existing prior to entry into the service as RA) and a note made on line 12 of the Form F card and in the health record as follows: "No previous admission for the underlying _____ which is not now present." If, however, the primary disability is present with the complication and has not been previously reported, the case shall be first taken up under the primary disability and changed to the complication as an ACD.

(RA) READMITTED: Each taking up on the sick list under the same diagnosis for a disability definitely a continuation or recurrence of one which previously has been made, shall be READMITTED. A subsequent new and independent occurance of the same disability shall be taken up as ADMITTED.

Every person who is taken up on the sick list because of a disability which is considered to have existed prior to entry into the service, shall be taken up as READMITTED.

When a patient is received from transfer, he shall be taken up as READMITTED with the disability under which transferred.

The established diagnosis in a case first taken up under DIAGNOSIS UNDETERMINED shall be reported as READMITTED.

Every person taken up on the sick list because of a disability incurred in a desertion status shall be taken up as READMITTED.

REMAINING: All cases remaining on the sick list on January 1st., from the previous year, shall be taken up as "____".

DUTY: All cases restored to duty shall be disposed of as discharged to DUTY.

Patients discharged from the service by reason of expiration of enlistment and retained in the hospital as supernumeraries shall be disposed of as to DUTY.

DIAGNOSIS CHANGED: A diagnosis may be changed by reason of:-

1. ERROR.
2. CONCURRENT disability which exists on admission or developes prior to current readmission for present illness and excludes recurrent disability.
3. INTERCURRENT disability which developes during present illness subsequent to present admission or current readmission and excludes recurrent disability.
4. RECURRENT disability, one which has continued or recurred and with which patient has previously been carried on the sick list.
5. COMPLICATION.
6. SEQUELA.
7. DIAGNOSIS ESTABLISHED used only when changing from diagnosis undetermined.

INDIVIDUAL STATISTICAL REPORT OF PATIENT

(NMS Form F and Fa Card)

This card is to be made out in duplicate on each patient admitted to the sick list and forwarded (Fa card) to the Bureau of Medicine and Surgery promptly upon disposition of the patient.

LINE 1 - (NAME) Enter last name in capital letters, followed by first and middle names.
(SERVICE NUMBER) Enter service number on all enlisted personnel - leave blank for officers and cadets.

LINE 2 - (RACE) For U.S. citizens enter "White-US" or "Negro-US" as the case may be. If a naturalized citizen enter as "White-NUS".
(PLACE OF BIRTH) Enter the state in which born in full, do not abbreviate.
(DATE OF BIRTH) Use numbers, i.e., 2-18-16, not February 18, 1916.

LINE 3 - (ENLISTMENT DATE) Enter in numbers the date of last enlistment.
(RATE) Enter as Sea2c.USN, Sea2c.USNR, ACMM(FR), Lt(jg)USN, etc.
(AVIATION) If patient has "flight orders" enter as "Fl.", if no "flight orders" as "N.Fl.".
(SERVICE) Count years and full months from original date of enlistment or entry into the service as entered on service abstract. Do not count days less than a month.

LINE 4 - (DIAGNOSIS NUMBER) Enter proper number as listed in the nomenclature, i.e. 801, not No.801 or #801.
(DIAGNOSIS) Enter diagnosis as listed in nomenclature in capital letters.

LINE 5 - (TAKEN UP AS) If original admission use "A", if an readmission or if disability existed prior to entry into the service, or was sustained while in desertion status, enter as "RA". If disability is a complication of a previous admission enter as "ACD".
(DATE) Enter date of admission to sick list for the present disability.
(DISPOSITION) If patient is transferred enter as "T"; if discharged to duty as "D"; if patient dies as "DD", or if diagnosis is changed as "C".
(DATE) Enter here date of final disposition of patient.
(SICK DAYS) Enter number of days patient was on the sick list, i.e., 3-8-42 to 3-12-42 = 4 sick days.

LINE 6 - (EPTE) If disability existed prior to entry into the service, state "YES" - if not, state "No". (PREVIOUSLY TAKEN UP) If taken up on line 5 as an RA, state if entry is so entered in health record. (DATE) If "Yes" is entered for previously taken up, enter date of original admission here. (KEY) Proper "Key Letter" from the nomenclature to be entered here in case of all injuries. (SPECIALTY) Proper "Specialty Letter" from the nomenclature to be entered here in case of all injuries resulting from airplanes, submarines, diving, etc.

LINE 7 - (PATIENT RECEIVED FROM) When patient is received from another ship or station, enter name of this ship or station here.

LINE 8 - (TRANSFERRED AS A PATIENT TO) If patient is disposed of as "T", enter name of activity to which transferred.

LINE 9 - (DIAGNOSIS CHANGED) If disposition is "C" on line 5, enter here the new diagnosis, diagnosis number and reason for changing diagnosis.

LINE 10 - (ACD) If taken up as "ACD" on line 5, enter here the number and diagnosis of the primary condition.

LINE 11 - (THIS CARD SENT FROM) Enter name and location of station, or name of ship, from which card is forwarded.

LINE 12 - (REMARKS) Use this space for classifications in all cases of injuries; place of contact in case of venereal diseases, and any other information needed to clarify individual cases.

CORRESPONDENCE

Correspondence that will be of concern to an Aviation Technician can be divided into three classes:

1. Official correspondence
2. Personal correspondence
3. Memorandums

Official correspondence embraces letters, messages, reports, requests, etc., written by naval personnel. All official letters shall have the proper file number in the upper left hand corner, along with the initials of the person dictating the letter and of the person typing the letter. Official letters should be accurate, simple in wording, concise without omitting essential details, and courteous in tone. A sufficient number of copies shall be made for the files. One carbon copy shall accompany each letter to its destination, and if forwarded through another office or offices, sufficient copies shall be attached and properly marked for the files of each office concerned.

Every person in the Navy making an official communication of any kind to any superior authority, shall send the letter unsealed to his commanding officer to be remarked upon and forwarded.

ENDORSEMENTS

As a general rule, a letter shall be answered by a separate letter and not by an endorsement.

When an endorsement for a letter requires another page, the subject of the letter is always repeated on the new page. When the endorsement is on the same page as the basic letter, the subject is not repeated.

All orders requiring endorsements involving payment of monies, shall be endorsed on the original orders, either front or back.

PERSONAL LETTERS

Personal letters are letters addressed to officials who have not adopted the form for official letters as used in the Navy, or from one naval officer to another, and are usually of a personal or semi-official nature.

Examples of these types of letters will be found on the following pages.

SAMPLE LETTER FORMS
(To be typed on official letter head paper)

OFFICIAL LETTER WITH ENDORSEMENTS

U.S. NAVAL AIR STATION,
Pensacola, Florida.

FILE_____ DATE_____

From: The Medical Officer.
To : The Chief of Naval Personnel.
Via : (1) The Commandant.
(2) The Chief of the Bureau of Medicine & Surgery.

Subject: _____(be brief)

Reference: (a)_____
(b)_____

Enclosure: (A)_____
(B)_____

1. _____

2. _____

(Signature)
(No rank required)

FILE_____ FIRST ENDORSEMENT U.S. Naval Air Station,
Pensacola, Florida,
Date_____

From: The Commandant.
To : The Chief of Naval Personnel.
Via : The Chief of the Bureau of Medicine & Surgery.

1. Forwarded.

(Signature)

FILE_____ SECOND ENDORSEMENT Bureau of Medicine & Surgery,
Navy Department,
Date_____

From: The Chief of the Bureau of Medicine & Surgery.
To : The Chief of Naval Personnel.

1. Forwarded, recommending approval.

(Signature)

PERSONAL LETTER

U.S. Naval Air Station,
Pensacola, Florida,
Date_____

Dear_____:

_____

_____

Sincerely,

Commander A.B.Jones,USN.,
U.S.S. TEXAS,
New York, N.Y.

_____

_____

U.S. Naval Air Station,
Pensacola, Florida,
Date_____

Sir:

_____

_____

Respectfully,

_____
Captain, U.S. Navy.

The American Consul,
Kingston, Jamaica.

_____

_____

MEMORANDUM

U.S.Naval Air Station,
Pensacola,Florida.

Date_____

MEDICAL DEPARTMENT MEMORANDUM NO.____

Subject: _____

1. _____

_____

_____

_____
Comdr. (MC), U.S.N.

PROCEDURE

FOR

A

RECORD OF PROCEEDINGS

OF A

BOARD OF MEDICAL EXAMINERS

The purpose of a Board of Medical Examiners is to examine and report upon the physical fitness of all officers on the active list upon their becoming due for promotion. The physical examination of a candidate for promotion shall relate only to his qualifications to perform the duties of the grade to which he seeks promotion, and not to those of any other grade.

The medical history of a candidate for promotion since the date of his last examination for promotion shall be considered in connection with his physical examination.

The record shall be signed by all members of the board and the recorder. It shall be complete in every respect and shall be forwarded direct to the Office of the Judge Advocate General, except that in the case of a candidate for appointment as assistant paymaster, chief pay clerk, pay clerk, or acting pay clerk, it shall be transmitted to the Naval Examining Board, and in case of reserve officers being commissioned in the regular Navy, to the Chief of the Bureau of Navigation when so directed.

The record must be typed with no errors or erasures therein. Reference should be made to Chapter 12, Sec. 872 of COURTS AND BOARDS for the proper form and variations to be used in each case.

The order in which a Record of Proceedings is put together for transmittal is as follows:

COVER PAGE	- Name, rank, place and date of examination.
PAGE "A"	- Certified copy of precept.
PAGE "B"	- Modification of precept when authorized.
PAGE "C"	- Certified copy of examinee's orders.
The Record of Proceedings	
PAGE "D"	- Statement of examinee as to his health.
PAGE "E"	- Transcript of medical history.

REPORTS AND FORMS SUBMITTED ON PHYSICAL EXAMINATION OF AVIATION and NON-AVIATION PERSONNEL

PURPOSE OF EXAMINATION	FORMS SUBMITTED	DESTINATION
A. PROMOTION.		
1. Officers (Aviators) USN & USMC	Record of Proceedings original to	J.A.G.
	copy to	File
	NMS Aviation Form #1 orig.& copy to	BuM&S
	copy to	File
	New descriptive sheet to	Health Record
2. Officers (Aviators) USNR & USMCR	NMS Aviation Form #1 orig & copy to	J.A.G.
	copy to	File
	New descriptive sheet to	Health Record
3. Officers USN & USMC (Non-Aviation)	Record of Proceedings original to	J.A.G.
	copy to	File
	By.M & S Form "Y" orig. & copy to	Bu.M&S
	copy to	File
	New descriptive sheet to	Health Record
4. Officers - Reserve (Non-Aviation)	Bu.M&S Form "Y" orig. & copy to	Bu.M&S
	copy to	File
	New descriptive sheet to	Health Record
5. Enlisted Men for appointment. (Except to Pay Clerk)	Record of Proceedings original to	J.A.G.
	copy to	File
	Bu.M&S Form "Y" orig.& copy to	Bu.M&S
	copy to	File
	New descriptive sheet to	Health Record
6. Enlisted Men for appointment to Pay Clerk.	Same as above except that the Record of Proceedings to	Nav. Exam. Bd.
7. Reserve Officers for appointment to Regular Navy	Record of Proceedings original to	J.A.G.
	copy to	File
	Form #1 or "Y" as required to	Bu.M&S
	New descriptive sheet to	Health Record

PURPOSE OF EXAMINATION	FORMS SUBMITTED		DESTINATION
B. ACTIVE DUTY	BuM&S Form "Y"	original & copy to	BuM&S
		copy to	File
1. Retired Personnel	Request for Health Record	to	BuM&S
	New descriptive sheet	to	Health Record
2. Reserve Personnel USN & USMCR	BuM&S Form "Y"	original to	BuM&S
		copy to	Examinee
		copy to	File
	Request for Health Record	to	Dist. Comdt.
(NOTE:			
(If aviator----------	NMS Av. Form #1	original & copy to	BuM&S
		copy to	File
C. RELEASE FROM ACTIVE DUTY			
1. All reserves	BuM&S Form "Y"	original to	BuM&S
		copy to	Examinee
		copy to	File
	Health Record	to	Dist. Comdt.
2. Aviation Cadets dropped from training.	Same as above.		
D. AVIATION ORIGINAL EXAMINATION			
1. SNA., SNAP, Av. Cadet(Applicants)	NMS Av. Form #1	original & copy to	BuM&S
	(Note:	copy to	File
	If examined at station other than Pensacola, send original & 2 copies:		BuM&S
2. SPECIAL EXAM.			
ALL personnel	NMS Av. Form #1	original & Copy to	BuM&S via C.O
3. RECHECK EXAM.			
	Make Jacket	to	File
All personnel when reporting for training.	NMS Av. Form #1 (rough)	to	File
	Audiometer	original to	BuM&S
		copy to	File
4. RECHECK EXAM.			
N.A. & N.A.P.	C.E.R. & Vision on Form #1	to	Jacket

PURPOSE OF EXAMINATION	FORMS SUBMITTED	DESTINATION
E. ADMISSION TO SICK LIST		
1. Officers	Suspension (RED) orig.& 2 copies to:	Log Room
	copy to:	Squadron
	copy to:	File
2. Enlisted Men	Same as above	Same
3. Aviation Cadets	Suspension (RED) original to:	Log Room
	copy to:	Squadron
	copy to :	File
F. DISCHARGE FROM SICK LIST		
1. Officers	Revocation (GREEN) same as above	Same
2. Enlisted Men	" " " " "	"
3. Aviation Cadets	" " " " "	"
G. TRANSFER OF AVIATORS		
1. Officers	Copy of orders to:	Jacket
	NMS Av. Form #1 (current copy) to:	New Station
	Health Record to:	New Station
	Jacket to:	Dead file
2. Enlisted Men	Same as above	Same
H. PHYSICAL EXAMINATION FOR THE NAVAL ACADEMY		
1. ALL Personnel	Bu. M&S Form "Y" original to:	Bu.M&S
	copy to:	Bu. Nav.
	copy to:	Supt. Nav. Academy
	copy to:	Senator or Congres
	:	man concerned.
	copy to:	File

BU. M & S FORM "Y"

All reports of physical examination, except physical examinations for aviation, shall be submitted on this form.

Form "Y" will be used in reporting the following physical examinations:

(a) Candidates for the Naval Academy.
1. Original to Bu.M&S
2. Copy to Bu.Nav.
3. Copy to Supt.Naval Academy
4. Copy to Congressman or Senator concerned
5. Copy to file

(b) Candidates for Appointment or Commission USN; USNR; USMC; USMCR.
1. Original to Bu.M&S
2. Copy to District Comdt. if reserve.
3. Copy to file

(c) Promotion of officers.
1. Original to Bu.M&S
2. Copy to file

(d) Retirement of officers.
1. Original to Bu.M&S
2. Copy to file

(e) ANNUAL Physical of officers.
1. Original to Bu.M&S
2. Copy to file

(f) Upon resignation, discharge or dismissal of officers.
1. Original to Bu.M&S
2. Copy to file

(g) Retired officers for active duty.
1. Original to Bu.M&S
2. Copy to file

(h) ALL Reserves upon reporting for and release from active duty.
1. Original to Bu.M&S
2. Copy to individual concerned
3. Copy to file

(i) Transfer of enlisted men to Fleet Reserve.
1. Original to Bu.M&S
2. Copy to file.

BLANK FORMS

All blank forms are obtained by requisition from the Medical Supply Depots on N.M.S. Form 4 (Requisition of Medical Supplies and Equipment.)

LETTERED FORMS

FORM "A" – Report of Arsenical Treatment.
Submitted: Monthly and Annually.

FORM "B" – Report of Allotment Expenditures.
Submitted: Quarterly.

FORM "D & Da" – Inventory of Material.
Submitted: Annually.

FORM "E" – Statement of Receipts & Expenditures of Property.
Submitted: Quarterly.

FORM "F & Fa" – Individual Statistical Report of Patient.
Submitted: As required.

FORM "F" (Smooth) – Abstract of Patients.
Submitted: Monthly.

FORM "G" – Hospital Ticket.
To accompany each patient on transfer to Hospital.

FORM "H" – Health Record.
Made out on enlistments, extensions, etc.

FORM "I" – Weekly report of Patients (Hospitals only).
Submitted: Weekly.

FORM "K" – Report of Dental Treatment.
Submitted: Monthly.

FORM "L" – Request for Dental Prosthetic Treatment.
Submitted: As necessary.

FORM "M" – Report of Medical Survey.
Submitted: As necessary.

FORM "N" – Report of Death.
Submitted: As necessary.

FORM "P" – Report of Surgical Operations.
Submitted: Quarterly.

NUMBERED FORMS

NMS HC FORM 3	Receipt, Transfer, & Disposition Card (Hospital Corps). Submitted: Upon any change in status of Hospital Corpsmen.
NMS HC FORM 4	Roster Report of Hospital Corps. Submitted: Monthly.
NMS FORM 4	Requisition & Invoice, Medical Supplies Submitted: As necessary.

REPORTS SUBMITTED BY LETTER

SANITARY REPORT	This is a report of the health and living conditions, etc., of the personnel of a ship or station, and is submitted monthly and annually to the Bureau of M. & S.
COMMUNICABLE DISEASES	A report of communicable diseases by classes, submitted monthly to Bureau of M. & S.
EPIDEMIOLOGICAL REPORT	A report of communicable disease when occurring in epidemic form. Submitted to Bureau of M. & S. when necessary.
REPORT OF CASUALTIES	Report of serious injury or death to Naval personnel. Submitted when necessary to Bureau of M. & S.

Reference should be made to Chapter 23, Manual of the Medical Department for further information on Reports and Returns.

SECTION VII

NMS AVIATION FORM #1

PAGES 113 to 120 inclusive

PHYSICAL EXAMINATION FOR FLYING
(The NMSAv-Form 1)

Helpful remarks on doing the Physical Examination for Flying and on recording the findings on Aviation Form No. 1.

See current circular letters for recent changes in physical requirements.

Each step is taken up in same order as written on Form-1 beginning with the first line of the first page. See pp.121 and 122.

The name should include ALL three names and NOT just initials, not even the middle initial. If examinee has no middle name, write "None". Write family name (surname) first. Example:-Smith, John Henry. Or, if examinee has no middle name:-Jones, James (none).

Place rank or rate in the next space. If he is not already in one of the services, write "Civilian." Include in this space appropriate Corps, such as (MC), (SC), (DC), (CC), etc. Also include classification, if a reserve, such as AV(T), AV(N), AV(S), HV(S), MC-V(S), MC-V(G), etc.

Branch of service includes U.S.N., U.S.N.R., U.S.N.(Ret.), U.S.M.C., U.S.M.C.R., U.S.M.C.(Ret.), U.S.C.G., U.S.A., etc.

Place of examination is where the examination is conducted, such as N.A.S., Pensacola, Florida; N.A.S., Norfolk, Virginia; N.A.S., Guantanamo Bay, Cuba; U.S.S. Lexington, etc.

Purpose of examination includes only four classifications which are as follows: Original, Annual, Promotion, and all others are Special,(state reason).

Date means the date the examination is conducted. If several days are required for the examination, the date of completion should be used.

Present station - the present station of duty of the examinee, if in the service, such as N.A.S., Alameda, California; U.S.S. Farragut; Bureau of Aeronautics, etc. If not in the service, it should be stated that he is in civilian life and give his present address. Example: Civilian Life - 102 N. Albermarle Street, Moline, Florida.

Flying status includes N.A., S.N.A., N.A.P., S.N.A.P., N.A.C. (often written A.C. or Av. Cad.), N.A. (airship), N.A. observer, N.F. Surg., and "Unclassified" for other persons ordered to duty involving flying. Flying status also includes applicants for the above and is usually recorded "App. Av. Cad.", App. S.N.A, etc. See paragraph 1539, page 33.

Place of birth. It is preferable to give town or city of birth as well as the state, if born in this country; otherwise, state city and country.

Age. Give age in years and months to the nearest month.

Years of service. Give total years of service to the half year. This includes both enlisted and commissioned service. Time spent going through the Naval Academy should NOT be included.

FLYING TIME last 12 months and to tal flying time usually includes Navy time only, however if the flyer has had considerable time out side of the Navy this should be included and notation made as to how much was non-Navy time. Example: 1800 Navy & 4600 Non-Navy.

TYPHOID PROPHYLAXIS. If he has had none then record NONE. If he has had only one course of prophylaxis state same and give date. Example: Completed one ccurs e 1939. If more than one--Completed 2 courses 1941. If he has had Booster Shot following regular courses record as 2 courses completed--booster shot 1941.

SMALLPOX VACCINATION. Record last vaccination, giving type of reaction and date, example: I.R. 1940 or Acc. R. 1941. If he has had the disease record as Smallpox 1932.

Note should be made of the three paragraphs under Instructions near top of first page of the Form-1.

The balance of the form will be taken up in order of the numbered sections.

SECTION 1. Previous medical history. On original examinations this section should be filled out by the Medical Officer examining the applicant. On subsequent examinations, if the man is in the service, the technician may fill it in. Copy from current health record any illnesses, injuries, etc. if there are any and if none state NONE SINCE LAST EXAMINATION. (see paragraph 1548 (b) (page 37.)

SECTION 2. General Build and Appearance. Should be recorded Athletic, Asthenic, Pyknic, or Dysplastic. If not a clear cut type and is a combination of two types (as is frequently the case) it may be recorded as Ath.-Asth. or Ath.-Pyknic, etc. The predominatory body type should be given first in the combination. The type should be noted by the Medical Officer and not the technicians.

POSTURE should be recorded as Excellent, Good, Poor, or Bad. See page 39.

FRAME. Means the bony framework--the size of the bones. A good index is the size of the man's fingers and bones of the wrist. It should be recorded as Light, Medium, or Heavy.

SECTION 3. Temperature. Temperature is taken with a thermometer and recorded. If it is above 98.6° F it is usually a good practice to discontinue examination until it is normal or below. However this question should be decided by the Medical Officer.

HEIGHT. Should be measured with NO shoes on. The maximum height for aviation personnel is 76 inches and the minimum is 64 inches. A recent change in regulations lowered the minimum height for Aviation Cadets from 66 inches to 64 inches (Bu. of Nav. Bulletin No. 293-7-1-41) See table page 38 and paragraph 1548 (c) page 37.

WEIGHT. Should be weighed with NO clothes on. Maximum weight is 200 lbs. and minimum is 124 lbs. A recent change in regulations lowered the minimum weight from 132 lbs. to 124 lbs. for Aviation Cadets. (Bu. of Nav. Bulletin No. 293-7-1-41) See table page 38 and paragraph 1548 (c) page 37.

Gain or Loss of weight usually refers to the time interval since last examination. If a good bit has been gained or lost in a short period of time, as, for example, if examinee has been ill and lost 30 lbs. in 2 mos., this should be recorded, both amount and time.

SECTION 4. Measurements. Chest measurements should be taken with the chest bare and with the tape passing around the chest at the level of angle of shoulder blade (lower margin) and passing around the front of chest at the same level (not higher in front than behind), which is usually a little below the nipples (nipples are not at the same level on all individuals). Have tape tight enough to be snug, but not tight enough to depress markedly the soft tissues. Instruct examinee to let all air he can out of lungs. Note circumference of chest at this point and record as "Expiration." Then, have him take a deep breath and note circumference of chest when lungs are full, and record as "Inspiration." Keep tape snug about the chest while it is expanding. Be on the alert for the last bit of expansion which may be due to the thickening (contracting) of the muscles attached to the lower part of the shoulder

blade. Do not include this last inch or so, if it is due to muscle thickening. A chest expansion of 4 inches is rather infrequent and one of 5 inches or more is quite rare. See paragraph 1548 (d), page 37.

The circumference of the abdomen is measured at the level of the umbilicus. Examinee should stand normally and should not be allowed to pull his abdomen in beyond where it ordinarily is.

SECTION 5. Respiratory. Should be written as recorded by Medical Officer. If nothing abnormal is found, it should be recorded as "Normal."

SECTION 6. Bones and joints. Should be written as recorded by Medical Officer. If nothing abnormal is found, it should be recorded as "Normal".

SECTION 7. Skin. Should be written as recorded by Medical Officer. If nothing abnormal is found, it should be recorded as "Normal".

SECTION 8. Condition of arteries. Should be written as recorded by Medical Officer. If nothing abnormal is found, it should be recorded as "Normal".

Hemorrhoids. Record as given by Medical Officer. If none recorded record as "None".

Pulse, blood pressure, and circulatory efficiency test should be recorded in accordance with paragraph 1548 (f), page 40.

Murmurs and arrythmia should be recorded by Medical Officer and, if none are present, it should be noted as "None". See paragraphs 1548 (e) and (f), pages 37 and 40.

SECTION 9. Abdomen and pelvis (condition of wall, scars, abnormality of viscer recorded by Medical Officer. If normal, record as "Normal".

Gastro-intestinal system. If normal, record as "Normal"; otherwise state the condition.

Hernia. Any hernia and its size should be recorded by the Medical Officer. If none is present, record as "None".

SECTION 10. Genito-urinary system. If normal, record as "Normal"; otherwise, Medical Officer will record the abnormal condition.

Urinalysis. Make sure the urine is passed by the examince and not some other individual.

Venereal Disease. If free from venereal disease, do NOT record as "Denies", but record as "None" or "none Apparent".

SECTION 11. Endocrine System. Should be written as recorded by Medical officer. If nothing abnormal is found, it should be recorded as "Normal"

SECTION 12. Teeth and Gums. Ordinarily, this section is completed by a Dental Officer; however, a time may arise when Medical Officer and technician will have to fill out this section. If completed by a Dental Officer, his name should be typed in and he should sign in proper place. See pages 66, 67, 68, and 69, and paragraph 1548 (g), page 41.

SECTION 13 AND 14. Should be filled out by Medical Officer. On annual physical examination, it is usually permissible to write in "Annual" and no more. See paragraph 1548 (h), page 43.

SECTION 15. Reflexes, motor disturbances, etc.

(a) Station. Record as Romberg Negative, Slightly positive, or pronouncedly positive.

(b) Gait. Described by Medical Officer or recorded as "Normal".

(c) Patellar reflexes. Record as absent (0), diminished (-), normal (+), hyperactive (++), or exaggerated (+++).

(d) Tremor. Described by Medical Officer or record as "None". Do NOT write in as "Normal".

(e) Tic. Described by Medical Officer or record as "None". Do not write in as "Normal".

(f) Other motor disturbances. Described by Medical Officer or recorded as "None ". Do not write in as "Normal".

(g) Peripheral circulation. Described by Medical Officer or recorded as "Normal". Do not write "None".

(h) Psychomotor tension. Described by Medical Officer or record as "Normal". Do not write in as "None".

See paragraph 1548 (h), page 43.

SECTION 16. Alcohol. Usually written Abstainer or None, Lightly, Occasionally, Moderately, Excessively, Chronic Alcoholic.

Drugs. Write in drug used as recorded by Medical Officer, or write Denies.

Tobacco. Abstainer, or None, or state what and how much he smokes daily, as, 1 pk. cigarettes daily.

SECTION 17. Epilepsy. Write as recorded by Medical Officer. Should use Denies, rather than None, or No history or evidence.

In all sub-headings write as recorded by Medical Officer. Denies should be used rather than None or Normal.

SECTIONS 18, 19, 20, 21, and 22. If no positive findings by the Medical Officer, they should be filled in as None or None Apparent or None Elicited. Do NOT write in Denies or Normal.

SECTION 23. Aeronautical Adaptability. Should be recorded as Favorable or Unfavorable. See paragraph 1548 (i), page 44.

Sections 17 to 23, inclusive, may be omitted at annual physical examination at the discretion of the Medical Officer.

SECTION 24. Visual Acuity. Test one eye at a time. If cannot read the 20/20 line at 20 feet, have examinee walk towards chart until he can read 20/20 line correctly. Record number of feet away from chart as numerator and 20 as the denominator; for example, if he had to go to 15 feet mark to read 20/20 line, then it should be recorded as 15/20. See paragraph 1549, p. 44 and 45.

SECTION 25. Depth Perception. Be certain examinee is lined up squarely in line with the apparatus so that when the pegs are side by side they will be exactly the same distance for examinee's eyes. Do NOT allow examinee to move head from side to side, nor to move movable peg from one end to the other to measure the half-way mark. Record vision for both when there is impairment of vision of either. See paragraph 1550, p. 45 and 46.

SECTION 26. Phorometer readings. They are made only at 6 meters' (20 feet) distance. See paragraphs 1551 and 1552, p. 46, 47, and 48. See p. 7 to 19, inclusive.

SECTION 27. Associated parallel movements. See actions of extraocular muscles p. 5, 6, and 7. See paragraph 1554, pp. 49 and 50. See also p. 21 and 23.

Tangent curtain diagnosis. See Red Lens test, paragraph 1553, p. 48 and 49. See also p. 23 and 24.

SECTION 28. Inspection of the Eyes. See paragraph 1555, page 50. If the Technician finds anything abnormal, he should call it to the attention of the Medical Officer. If pupils are normal, they are usually recorded as : Equality, "Equal"; shape, "round"; reaction, "normal to light and accommodation."

SECTION 29. Accommodation. See paragraph 1556, p. 50 and 51.

TABLE

AGE	DIOPTERS	AGE	DIOPTERS	AGE	DIOPTERS	AGE	DIOPTERS
18	11.9	25	10.2	31	8.6	37	6.8
19	11.7	26	9.9	32	8.3	38	6.5
20	11.5	27	9.6	33	8.0	39	6.2
21	11.2	28	9.4	34	7.7	40	5.9
22	10.9	29	9.2	35	7.3	45	3.7
23	10.6	30	8.9	36	7.1	50	2.0
24	10.4						

SECTION 30. Angle of convergence. See paragraph 1557, p. 51. See also p. 20, 21, and Table of Angles, p. 22.

SECTION 31. Central color vision. See paragraph 1558, page 52.

SECTION 32. Field of vision. See paragraph 1559, p. 53.

SECTION 33. Refraction. See paragraph 1560, p. 53, 54, and 24.

SECTION 34. Ophthalmoscopic examination. See paragraph 1561, page 54. Is done by Medical Officer and written as recorded by him.

SECTION 35. History of ear trouble. Write as recorded by Medical Officer. Usually written as "Denies" if there are no positive findings.

SECTION 36. Examination of the ears. See paragraph 1562 pages 54 and 55. See also pages 26, 27, 28, and 29.

SECTION 37. Condition of nares. See paragraph 1563 page 55. See also page 29. If no positive findings are recorded by Medical Officer, the normal condition is usually written "Normal" or "Adequate Ventilation".

SECTION 38. Tonsils. After the word "tonsillitis" a short statement as to history of tonsilitis should be written in such as: "Denies recent attacks" or "History of frequent attacks" etc.

Write condition of tonsils as recorded by Medical Officer. See pages 30 and 31.

SECTION 39. Adenoids. Written as recorded by Medical Officer. Usually written as "None" or "None apparent".

SECTION 40. Eustachian Tubes. Written as recorded by Medical Officer, If normal usually written as "Patent".

SECTION 41. Equilibrium. See paragraph 1564 p. 55 and 56. See also page 28 and 29.

SECTION 42. Balancing test. See paragraph 1564 (d) & (e) page 56.

SECTION 43. Defects. Indicate the defect by number and state whether "Considered disqualifying" or "Not considered disqualifying".

SECTION 44. Write in Yes or No in the appropriate space. Another classification is "Flight Surgeon" and should state Yes or No.

SECTION 45. Write in yes or no; if no then limit of duty should be stated. Example: "Ground duty only".

SECTION 46. Recommendations. Is or is NOT physically qualified and aeronautically adapted for duty involving aviation training, or--

Is or is NOT physically qualified and aeronautically adapted for actual control of aircraft.

If examination is for promotion the following should be added to the above: "and for promotion".

With some cases the men may be "Physically qualified and NOT aeronautically adapted".

SEE CURRENT CIRCULAR LETTERS FOR RECENT

CHANGES IN PHYSICAL REQUIREMENTS.

NMSAv—Form 1
(1939)

Physical Examination for Flying

Name _____ (Surname) _____ (Christian names) _____ (Rank or rate) U. S. _____ (Branch of service)

Examination: Place _____ Purpose _____ Date _____

Present station _____ Flying status _____

Birth _____ (Place) _____ (Date) Age _____ (Years) (Months)

Years of service _____ Flying time last 12 months _____ (Hours) Total flying time _____ (Hours)

Typhoid prophylaxis _____ Smallpox vaccination _____

Instructions: Be definite in statement. To assist the statistician in selecting significant data, it is requested that all abnormal conditions be given a diagnostic title as listed in the Nomenclature of the Manual of the Medical Department, United States Navy, 1938. Examiners shall express an opinion as to whether any defects recorded are considered sufficient to disqualify.

1. The preparation of this form shall include all statements relating to aeronautical adaptability. It shall be forwarded via the Commanding Officer to the Bureau of Medicine and Surgery, Navy Department, for approval as follows: On original examination, when found qualified, in triplicate, and when found not qualified, in duplicate. On annual physical examination and all other examinations, except originals, inclusive of Naval and Marine Corps Reserve, it shall be forwarded in duplicate.

2. One copy of this form, bearing the indorsement of the Bureau of Medicine and Surgery, will be returned to the ship or station submitting the report, for retention in the local files.

3. When an individual is transferred to a new ship or station, the copy of this form, bearing the indorsement of the Bureau of Medicine and Surgery, shall be forwarded by the medical officer to the medical officer of the new ship or station to which he is to be attached.

General Examination

1. Previous medical history	Date	Duration	Complication
(a)			
(b)			
(c)			
(d)			
(e)			
(f)			

2. General build and appearance _____ Posture _____ Frame _____
3. Temperature _____ Height _____ inches. Weight _____ pounds. Gain _____ pounds. Loss _____ pounds.
4. Measurements: Chest expiration _____ inches, inspiration _____ inches. Abdomen _____ inches.
5. Respiratory _____
6. Bones and joints _____
7. Skin _____
8. Cardiovascular system _____
   (a) Condition of arteries _____
   (b) Condition of veins _____ Hemorrhoids _____
   (c) Pulse rate per minute: Prone _____; standing _____; after exercise _____; return to normal _____
   (d) Blood pressure: Prone: Syst. _____; diast. _____ Standing: Syst. _____; diast. _____
   (e) Heart _____
      (1) Murmurs _____
      (2) Arrythmias _____
   (f) Circulatory efficiency rating _____
9. Abdomen and pelvis (condition of wall, scars, abnormality of viscera) _____
   (a) Gastro-intestinal system _____
   (b) Hernia _____

16—11708

10. Genito-urinary system _____

Urinalysis: Sp. gr. _____, alb. _____, sugar _____, microscopical _____

Venereal disease _____ Serological tests (when required) _____

11. Endocrine system _____

12. Teeth and gums (disease or anatomical defect): _____

Missing teeth _____
(List numbers)

Nonvital teeth _____
(List numbers)

Periapical disease _____
(Degree)

Marked malocclusion _____
(Yes or no)

Lack of serviceable occlusion _____
(Yes or no)

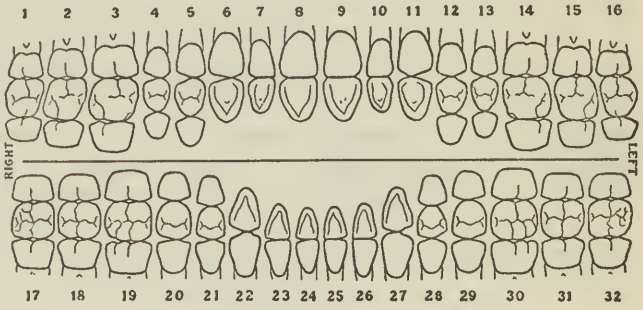
Pyorrhea alveolaris _____
(Degree)

Teeth replaced by bridges _____
(List numbers)

Meets dental requirements _____
(Yes or no)

Dentures _____
(Description)

Mark missing teeth by X whether replaced or not. Show size and position of caries in black, use red to indicate fillings and restorations.



_____
(Signature of examiner)

Neuropsychiatric Examination

13. Family history of mental disorders, particularly the psychoneuroses _____

14. Personal history _____

15. Reflexes, motor disturbances, etc.:

(*a*) Station _____ (*e*) Tic _____

(*b*) Gait _____ (*f*) Other motor disturbances _____

(*c*) Patellar reflexes _____ (*g*) Peripheral circulation _____

(*d*) Tremor _____ (*h*) Psychomotor tension _____

16. Alcohol _____ Drugs _____ Tobacco _____
(See paragraph 137(10) N. R.)

17. Epilepsy _____
(Grand mal and petit mal)

(*a*) Enuresis _____ (*e*) Migraine _____

(*b*) Stammering _____ (*f*) Somnambulism _____

(*c*) Dizziness _____ (*g*) Fainting _____

(*d*) Convulsions _____

(*h*) Other disturbances in consciousness (amnesia, momentary lapses, prolonged absences, double and multiple personality, etc.) _____

18. Anxiety trends _____
(Whether pathological)

19. Elation and depression _____
(Whether pathological)

20. Irritability and apathy _____
(Whether pathological)

21. Phobias _____
(Whether pathological)

22. Sensory disturbances _____

23. Aeronautical adaptability _____

Remarks: _____

Eye Examination

24. Visual acuity: R. E. ---- L. E. ---- Binocular vision ----
(Without lenses—Recorded only when visual defects exist)

25. Depth perception at 6 meters ---- mm.

26. Phorometer readings (diopters):
At 6 meters: Eso. ---- D. Exo. ---- D. R. H. ---- D. L. H. ---- D.
At 33 cm.: Eso. ---- D. Exo. ---- D. Prism divergence ---- D.

27. Associated parallel movements ---- Nystagmus ----
Tangent curtain diagnosis ----
(In all cases of muscular imbalance)

28. Inspection ----
Pupils: Equality ----; shape ----; reaction ----

29. Accommodation: R. E. ---- D. L. E. ---- D.

30. Angle of convergence: PcB ---- mm. Pd. ---- mm. Angle ----

31. Central color vision: R. E. ---- L. E. ----
(If defective, state edition of Stilling's plates used)

32. Field of vision. Form: R. E. ---- L. E. ----
Color: R. E. ---- L. E. ----

33. Refraction, on original examination and when indicated (Homatropine). Tension ----
Retinoscopic findings: R. E. ---- L. E. ----
Cycloplegic acceptance (reads 20/20 with): R. E. ---- L. E. ----

34. Ophthalmoscopic examination: R. E. ---- L. E. ----

Ear Examination

35. History of ear trouble:
(*a*) Ringing or buzzing, earache, or discharge ----
(*b*) Severe injuries to head ----

36. (*a*) External auditory canal: Right ---- Left ----
(*b*) Membrani tympani: Right ---- Left ----
(*c*) Hearing: Spoken voice (when indicated), binaural ----/15 feet; right ----/15 feet; left ----/15 feet.
Right ear, watch ----/40 inches; coin click ----/20 feet; whispered voice ----/15 feet.
Left ear, watch ----/40 inches; coin click ----/20 feet; whispered voice ----/15 feet.

Nasopharynx

37. Condition of nares: Right ---- Left ----

38. Condition of tonsils and history of attacks of tonsilitis:
Right ---- Left ----

39. Presence of adenoids ----

40. Condition of eustachian tubes after politzerization ----

Equilibrium

41. Equilibrium. Barany chair vestibular test, on original examination and when indicated.
Nystagmus: (*a*) Rotation to right, 10 turns in 20 seconds, horizontal nystagmus to left ---- seconds.
(*b*) Rotation to left, 10 turns in 20 seconds, horizontal nystagmus to right ---- seconds.
Falling test: (*a*) Rotation to right, 5 turns in 10 seconds. Falls to ----
(*b*) Rotation to left, 5 turns in 10 seconds. Falls to ----
(NOTE.—Rotation nystagmus of 26 seconds is normal. A variation of 10 seconds above and 12 seconds below is allowable.)

42. Self-balancing test: Right ---- attempts. Left ---- attempts. Result ----

Result of Examination

43. Defects ----------
(Indicate by number and state whether considered sufficient to disqualify. See General Order 122)

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44. Is candidate qualified for duty involving flying as: (*a*) Pilot ---------- (YES or NO); (*b*) observer ---------- (YES or NO); (*c*) student aviator ---------- (YES or NO); (*d*) other classification ----------
(Specify classification and state YES or NO)

45. Is the individual physically qualified to perform all of his duties at sea (and in the field, in the case of Marine Corps officer)? ---------- (State YES or NO) If not, state limit of duty ----------

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46. Recommendations ----------

Medical Corps, U. S. Navy.

Medical Corps, U. S. Navy.

Medical Corps, U. S. Navy.

FIRST INDORSEMENT:

To: Bureau of Medicine and Surgery, Navy Department, Washington, D. C.

1. Forwarded.


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